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Modelling of Ignition and Buildup to Detonation in Slurry Explosives

(Phase III)

Report Submitted to
Department of Supply and Services
for
The Canada Centre for Mineral and Energy, Technology
(CANMET)
Department of Energy, Mines and Resources

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SCOPE OF WORK

The objective of this program is to investigate the hazardous properties of explosives by developing a model to describe the ignition and buildup process in bubble sensitized slurry explosives under dynamic loading.

The "Statement of Work" for Phase III as indicated in DSS File No. 20SU.23440-1-9072 includes:

1. Investigation of the critical impact velocity of cylindrical projectiles on nitromethane under various physical conditions.
2. Numerical simulation of initiation to detonation in nitromethane under the impact of cylindrical projectile.
3. A further search of a code better than the TENSOR CODE for refining the calculations with and without chemical reaction (burning process).

SUMMARY

The study of Phases I and II on the formation and distribution of hot spots in slurry explosives under projectile impact was extended. The properties of projectile was incorporated in the calculation in this work. The explosive component of the hypothetical slurry explosive considered in most cases was liquid nitromethane. In the calculation, the Arrhenius burning rate was used for nitromethane instead of the Forest Fire Model because of the lack of necessary experimental data for determining the coefficients of the model. The volume percentage of air in the slurry explosive was varied from 15.0 to 30.0. The projectile velocity considered was in the range of 200 to 600 m/sec. In the study, the effects of inert solid to liquid ratio, the dimension of the explosive container, and the presence of a solid explosive (PBX 9404) in addition to nitromethane were also investigated. A total of forty-four cases have been studied in this work.

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LEGEND FOR FIGURES

Pressure

□	below 0.00001 Kbar	⧖	42 - 48 Kbar
○	0.00001 - 6 Kbar	Y	48 - 54 Kbar
△	6 - 12 Kbar	⌑	54 - 60 Kbar
+	12 - 18 Kbar	✳	60 - 66 Kbar
X	18 - 24 Kbar	⧖	66 - 72 Kbar
◇	24 - 30 Kbar	I	72 - 78 Kbar
▽	30 - 36 Kbar	✡	78 - 84 Kbar
⧖	36 - 42 Kbar	—	above 84 Kbar

Mesh Zones

◇	K = 3, L = 3	X	K = 3, L = 12
△	K = 3, L = 6	□	K = 3, L = 15
+	K = 3, L = 9		

INTRODUCTION

This report describes the activities and results obtained during the third Phase of the study on the modelling of ignition and buildup to detonation in slurry explosives. It covers the period from September 1981 to August 1982.

The behaviour of slurry explosives with hypothetical compositions under projectile impact has been studies in Phase I by a numerical method during the buildup period but before combustion has taken place. Slurry explosives with solid phase as the only explosive component has been studied in Phase II. In the present work, slurry explosives with liquid phase as the only explosive component has been considered, using nitromethane as the liquid explosive in the hypothetical composition.

METHOD OF COMPUTATION

The computation procedure used in this work followed that used in Phase II. However, the projectile as well as the air above the slurry explosive and beside the projectile were included in the computational mesh. Consequently, the boundary conditions used in the computation were modified accordingly.

The part of the slurry explosive which was treated mathematically was subdivided and defined by a Lagrangian coordinate system as shown in Figure 1.

In defining the boundary conditions, the velocities of the mesh zones immediately above the projectile were set to equal to

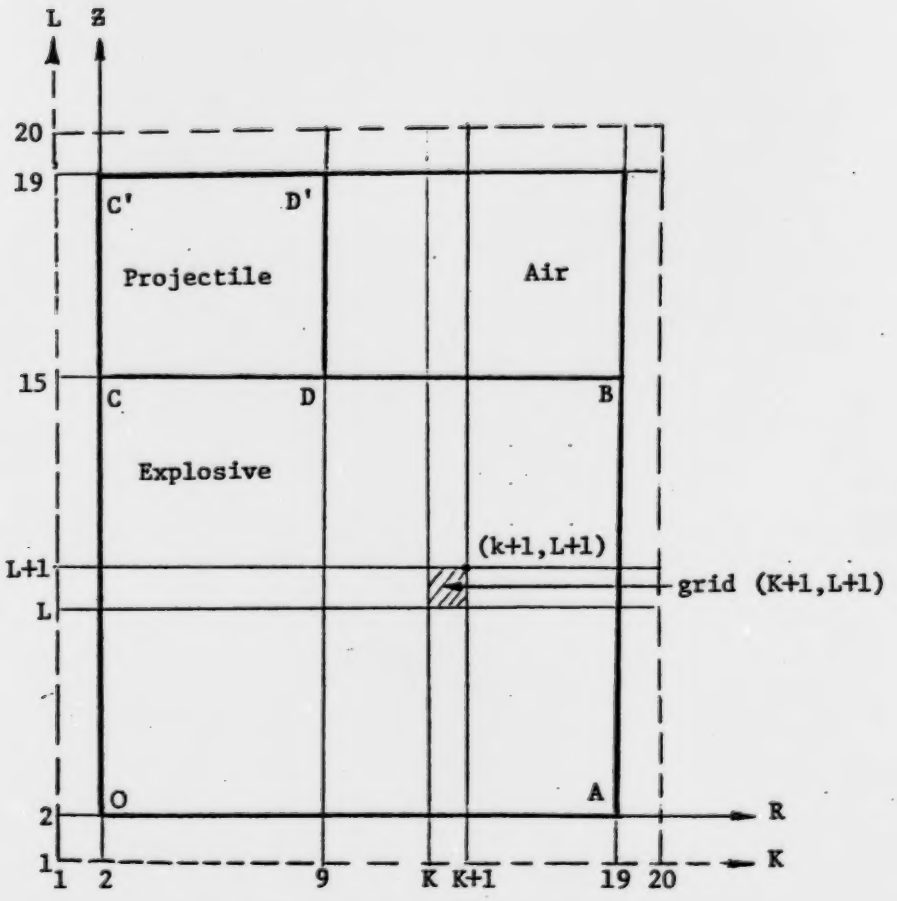

Fig. 1 Identification of the Lagrange grids of the initial position of the physical model.

those adjacent zones but immediately within the projectile. Similarly, the velocities of the mesh zones immediately above the slurry explosive were also set to equal to those adjacent zones but immediately within the explosive. In addition, the pressure, components of deviation of artificial viscosity and damping terms were set to zero for the mesh zones above the projectile and above the explosive. The boundary conditions set at the centre of the explosive, at the side and bottom of the explosive container remained the same as those defined in the work of Phase I.

Since the projectile was considered in the calculation, properties of the projectile as well as the parameters of the HOM equation of state for the projectile must be given as input parameters. The values of these parameters together with the properties of the hypothetical slurry explosive, the computational lattices and all other parameters used in the calculation are listed in Table 1.

BURNING RATE

The Arrhenius burning rate expression was used in this work because of the lack of necessary experimental data for the determination of the coefficients of the Forest Fire Model for the burning rate.

The Arrhenius rate equation is expressed by Equation 1:

$$\frac{dW}{dt} = W^{*}Ze^{-\overset{*}{E}/T} \qquad (1)$$

TABLE 1

PHYSICAL DATA USED IN THE COMPUTATION

1. Properties of Hypothetical Slurry Explosives

	Liquid	Solid	Air
Density (g/cm^3)	1.128	1.844	0.0012
Sound Velecity (m/sec)	1647	2423	340
γ Value	2.17	2.91	function of temperature
C_3, C_4	0.75		
Volume Percentage			15 ~ 30
Length of the Explosive (cm)	4.445		
Radius of the Explosive (cm)	5.715		

2. Properties of the Projectile (Brass)

Length (cm)	1.27
Diameter (cm)	5.08
Density (g/cm^3)	8.413
Velocity (m/sec)	200 ~ 600

3. Properties of Computational Lattices

Number of Lattice	r-direction:16-24
	z-direction:16-24
Length of a Lattice	r-direction:0.3175 cm
	z-direction:0.3175 cm
Time Increment	0.05 μsec

4. Parameter of the HOM Equation of State [1]

Liquid (Nitromethane)

$C = 0.1647$
$S = 1.637$
$VSW = 0.01$
$C_1 = 0.0$
$S_1 = 0.0$
$F_s = 5.41170789261$
$G_s = -2.72959322666$
$H_s = -3.21986013188$
$I_s = -3.90757138698$
$J_s = 2.39028184133$
$\gamma = 0.6805$
$C_v = 0.414$
$V_0 = 0.886524823$
$T_0 = 300$
$P_0 = 0.000001$
$\alpha = 0.0003$

Gas Product

$A = -3.11585072896$
$B = -2.35968123302$
$C = 0.210663268988$
$D = 0.00380357006508$
$E = -0.00353454737231$
$K = -1.39936678316$
$L = 0.479350272379$
$M = 0.0606707773429$
$N = 0.00410672785525$
$O = 0.000113326560531$
$Q = 7.79645302519$
$R = -0.533007196907$
$S = 0.0709019736856$
$T = 0.0206149976021$
$U = -0.00566139653675$
$C_v = 0.556$
$Z = 0.1$

Projectile

$C = 0.3726$
$S = 1.434$
$C_1 = 0.0$
$S_1 = 0.0$
$\gamma = 1.87$
$C_v = 0.09$
$\alpha = 0.00002053$
$V_0 = 0.1188636$
$T_0 = 300$
$P_0 = 0.000001$

The coefficients used in The Forest Fire Model and C.-J. detonation velocity of solid (PBX 9404): see Final Report of Phase II.

5. C.-J. Detonation Velocity of Nitromethane = 0.6463 cm/μs[1]

6. Reaction Rate Parameters[1]

   Activation Energy ($\overset{*}{E}$) = 53600 cal/mole
   Frequency Factor ($\overset{*}{Z}$) = 4×10^{8} (μsec^{-1})
   Heat of Chemical Reaction (Q) = 0.2444 Kcal/g

where W = mass fraction of the undecomposed explosive

Z* = frequency factor

E* = activation energy

R = gas constant

T = temperature of the air bubble entrained in the explosive.

This burning rate expression for the liquid was used in this work to replace the burning rate of the Forest Fire Model for the solid explosive. However, the proposed procedure of computation was identical to that used in Phase II as shown in Figure 2.

CALCULATION RESULTS

A total of forty-four cases has been considered in this work. Among them, thirty-three cases (Cases 1 to 33) were calculated with the size of the slurry explosive container identical to that used in Phases I and II. However, the projectile as well as the air above the slurry explosive and beside the projectile were included in the computational mesh as mentioned above. For this reason, the computational lattices were changed to

r-direction:20

z-direction:20

in these cases from

r-direction:16

z-direction:20

in Phases I and II. The length of a lattice was kept identical in Phases I, II and III. The conditions investigated and the results obtained in these cases are summarized in Table 2. The calculated

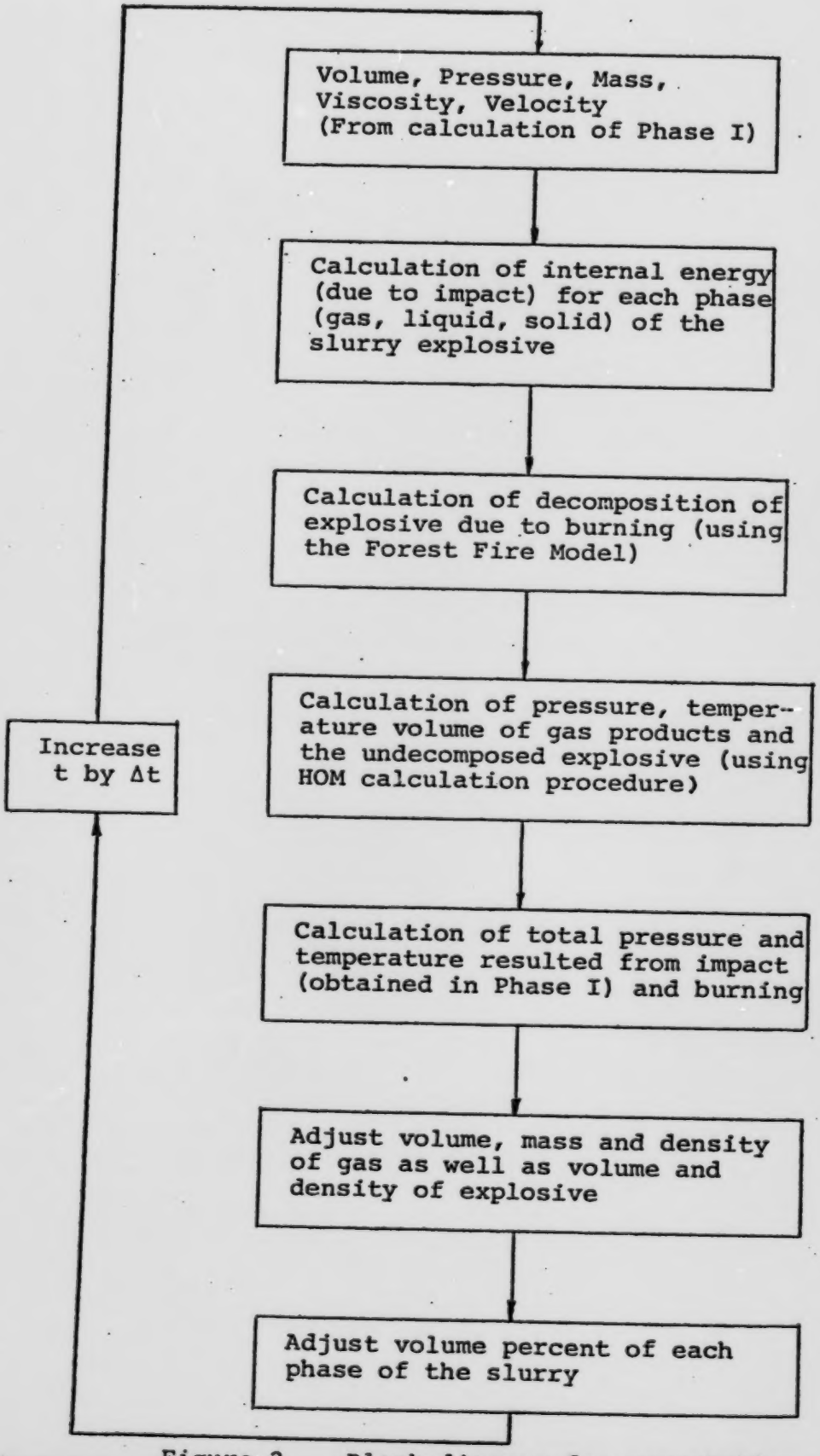

Figure 2 Block diagram for computation

TABLE 2 A SUMMARY OF CONDITIONS INVESTIGATED AND RESULTS OBTAINED IN THIS WORK
(NOK = 20 NOL = 20)

Case	Figure	Solid-to-Liquid ratio	Projectile velocity m/sec	Air Volume %	Apparent Density g/ml	Decomposition of Liquid Explosive	Max. Time for Computation μ sec	Starting Time for Decomposition μ sec	Max. Air Bubble Temperature °K x 1000
1	3	1	300	15	1.263	No	20	-	2.2
2	4	1	400	15	1.263	No	14	-	2.5
3	5	1	600	15	1.263	Yes	20	3.0	2.6
4	6	1	300	17.5	1.226	No	20	-	2.1
5	7	1	400	17.5	1.226	No	14	-	2.4
6	8	1	600	17.5	1.226	Yes	8	3.8	2.7
7	9	1	200	20	1.188	Yes	30	20.2	5.3
8	10	1	300	20	1.188	Yes	20	8.2	7.0
9	11	1	400	20	1.188	Yes	14	4.85	5.4
10	12	1	600	20	1.188	Yes	8	2.4	6.0
11	13	1	300	22.5	1.152	No	30	-	2.1
12	14	1	400	22.5	1.152	No	30	-	2.3
13	15	1	600	22.5	1.152	Yes	22	4.95	2.7
14	16	1	300	25	1.115	No	30	-	2.1
15	17	1	400	25	1.115	No	30	-	2.4
16	18	1	600	25	1.115	Yes	20	5.75	2.7
17	19	1	400	27.5	1.077	No	30	-	2.2
18	20	1	600	27.5	1.077	Yes	20	7.15	2.7
19	21	1	300	30	1.040	No	30	-	1.8
20	22	1	400	30	1.040	No	18	-	2.2
21	23	1	600	30	1.040	Yes	14	11.7	2.6
22	24	2	400	20	1.285	No	14	-	2.4
23	25	2	600	20	1.285	Yes	14	4.3	2.7
24	26	2	400	22.5	1.244	No	30	-	2.3
25	27	2	600	22.5	1.244	Yes	26	4.75	2.7
26	28	3	400	20	1.332	No	14	-	2.4
27	29	3	600	20	1.332	Yes	14	4.05	2.7
28	30	3	400	22.5	1.291	No	30	-	2.4
29	31	3	600	22.5	1.291	Yes	26	4.65	2.7
30	32	4	400	20	1.361	No	14	-	2.5
31	33	4	600	20	1.361	Yes	14	3.80	2.7
32	34	4	400	22.5	1.318	No	30	-	2.4
33	35	4	600	22.5	1.318	Yes	26	4.60	2.7

values obtained for five mesh zones for these cases are also depicted in Figures 3 to 35. In these figures, profiles of deformation and temperature as a function of time, temperature-time curves, and pressure-time curves, are presented in parts A, B and C, respectively. For the first twenty-one cases (Cases 1 to 21), the solid to liquid ratio (S/L) was taken to be unity. For the next twelve cases (Cases 22 to 33), the solid to liquid ratio varied from two to four.

In all the cases studied, a minimum air bubble temperature of 2700°K was considered sufficient for the decomposition of nitromethane.

The results obtained for Cases 1 to 21 (S/L = 1) indicate that for Cases 1, 4, 11, 14 and 19, of which the volume percentage of air was 15, 17.5, 22.5, 25 and 30, respectively, the decomposition of nitromethane did not take place. In these cases, a bullet impact velocity of 300 m/sec. was used in the computation. The pressures and temperatures of the air bubbles generated at this impact velocity were too low to cause the decomposition of the explosive. The same situation applies for Cases 2, 5, 12, 15, 17 and 20, of which the volume percentage of air was 15, 17.5, 22.5, 25, 27.5 and 30, respectively. A bullet impact velocity of 400 m/sec. was used in the computation of these cases. Apparently, the increase of the impact velocity was not sufficient. When a bullet impact velocity of 600 m/sec. was used in the computation, the generated pressures and temperatures were high enough to cause the decomposition of nitromethane as shown by the results of Cases

3, 6, 10, 13, 16, 18, and 21, of which the volume percentage of air was 15, 17.5, 20, 22.5, 25, 27.5, and 30 respectively.

In the above-mentioned cases (Cases 1-6, 10-21), the first peak pressure appearing in the explosive was caused by the impact of the bullet alone. The second and subsequent peak pressures were caused by rarefaction from the walls of the container. These peak pressures were not high enough to generate the required temperature for the decomposition of nitromethane for the cases when a bullet impact velocity of 300 m/sec. or 400 m/sec. was used in the computation. However, these peak pressures were sufficient for the cases when a bullet impact velocity of 600 m/sec. was used, and the decomposition of nitromethane was caused by the impact of the bullet alone.

On the other hand, for Cases 7, 8,and 9, of which a bullet impact velocity of 200, 300, and 400 m/sec., respectively, was used in the computation, the decomposition of nitromethane did take place. An air volume percentage of 20 was used in these cases. A careful investigation of the pressure-time curves reveals that the decomposition of nitromethane in these cases was caused by rarefactions. For this reason, the time required for the decomposition of nitromethane to take place in these cases was much longer than that in the cases when a bullet impact velocity of 600 m/sec. was used.

The results obtained for Cases 22 to 33 indicate that at a bullet impact velocity of 600 m/sec., the decomposition of nitro-

methane took place in all the cases studied (Cases 23, 25, 27, 29, 31 and 33), regardless whether the solid to liquid ratio was 2, 3 or 4. When a bullet impact velocity of 400 m/sec. was used in the computation, no decomposition of nitromethane was observed in all the cases studied (Cases 22, 24, 26, 28, 30 and 32), regardless whether the air volume percentage was 20 or 22.5. A comparison of the results obtained for Cases 9, 22, 26 and 30 indicates that the increase of the solid to liquid ratio from 1 to 2, 3, or 4 changed the decomposition of nitromethane from "yes" to "no".

It should also be mentioned that if the maximum time for computation could be extended, some of the results presented in Table 2 might be changed from "No decomposition of nitromethane" to "decomposition of nitromethane occurred" (for example, Cases 5 and 12). However, due to the large distortion of the grid after long computation time, the lagrange coordinate system used in the computer code could not handle this situation.

Seven cases (Cases 34 to 40) were investigated for the purpose of determining the effect of container size on the decomposition of nitromethane in the hypothetical slurry explosive. The computational lattices of the r- and z- directions varied from 16, 16 to 24, 24, using the same lattice length as that for the first 33 cases. The conditions investigated and the results obtained are summarized in Table 3. The results obtained indicate that the locations of the hot spots, as indicated by the maximum temperatures of the air bubbles in the mesh zones under consideration, varied due to the pressure waves of rarefaction from the

TABLE 3 THE EFFECT OF CONTAINER SIZE ON THE DECOMPOSITION OF NITROMETHANE IN THE HYPOTHETICAL SLURRY EXPLOSIVE (S/L = 1)

Case	Projectile Velocity m/sec	Air Volume %	Apparent Density	Decomposition of Liquid Explosion	Max. Time for Computation μ sec	Starting Time for Decomposition μ sec	Max. Air Bubble Temperature °K x 1000	NOK r-direction	NOL z-direction
34	200	20	1.188	Yes	30	27.3	5.7	16	16
35	200	20	1.188	Yes	27	24.3 - 27	21	24	24
36	300	17.5	1.226	No	30	-	2.2	20	24
37	300	17.5	1.226	No	30	-	2.2	24	24
38	300	20	1.188	Yes	30	14.8	7.3	20	24
39	300	20	1.188	Yes	20	8.2	7.9	24	20
40	300	20	1.188	Yes	30	14.9	22	24	24

bottom and side walls of the container. The results obtained for Cases 34 and 35 indicate that the maximum air bubble temperatures reached are higher than that of Case 7, but the starting time for decomposition for Case 7 is shorter than that for Cases 34 and 35. The same situation applies for Cases 38 and 40, when the results of these two cases are compared with the results obtained for Case 8. For Case 39, the starting time for decomposition was practically the same as that for Case 8 but the maximum air bubble temperature reached is higher. The decomposition of nitromethane did not take place for Cases 36 and 37, the conditions investigated for these two cases are identical to that for Case 4 with the exception of the container size. The solid component in all the above-mentioned cases (Cases 1 to 40) was assumed to be an inert material.

An investigation was subsequently made in which both liquid and solid explosives were considered in the hypothetical slurry explosive (Cases 41-44). In the computation, nitromethane was considered as the liquid explosive and PBX 9404 the solid explosive. Both explosives were treated as if they were not soluble in each other. The conditions investigated and the results obtained are summarized in Table 4. In all the cases studied, nitromethane decomposed a few μ-seconds ahead of PBX 9404. It appears that the decomposition of PBX 9404 was caused by the high pressure generated by the decomposition of nitromethane.

TABLE 4 A SUMMARY OF CONDITIONS INVESTIGATED FOR A HYPOTHETICAL SLURRY EXPLOSIVE CONTAINING NITROMETHANE AND PBX 9404 (S/L = 1, Air Volume Percentage = 20, NOK = NOL = 20)

Case	Projectile velocity m/sec	Max. Time for Computation μ sec.	Starting Time for Decomposition, μ sec		Max. Air Bubble Temperature °K x 1000
			Nitromethane	PBX 9404	
41	200	27.0	20.2	25.6	5.4
42	300	16.8	8.2	14.65	7.1
43	400	11.6	4.9	9.25	92.0
44	600	6.5	2.4	5.35	5.8

Notes:

a. Mutual solubilities were not considered

b. The Arrhenius burning rate was used for the liquid explosive

c. The Forest Fire Model was used for the solid explosive

CONCLUSIONS

The results obtained in this investigation indicate that:

1. The impact pressure should be high enough to generate sufficiently high temperature for the initiation of the decomposition of the liquid explosive.
2. The volume percentage of air plays an important role in the generation of high temperature in the slurry explosive. At identical projectile velocity, the volume percentage of air must be within a certain range for generating the temperature required for initiating the decomposition of the liquid explosive component of the slurry. For example, at a projectile velocity of 300 m/sec. or 400 m/sec., the decomposition would not start with this volume percentage of air at 15 or 30, but would start when the volume percentage of air is 20.
3. The decomposition of the hypothetical slurry explosive studied occurred either by the first peak pressure caused by the impact of the projectile or by the rarefaction pressure wave.
4. The dimensions of the explosive container play a role in the starting time for decomposition of nitromethane due to the variation of the rarefaction pressure waves from the bottom and the walls of the container.
5. At a high projectile velocity (600 m/sec.), the decomposition of nitromethane took place in all the cases studied, regardless of the inert solid to liquid explosive ratio.

6. For the same amount of air present in the slurry explosive, the impact velocity must be increased as the inert solid to liquid ratio increases to ignite the liquid explosive nitromethane.
7. When a solid explosive (PBX 9404) instead of an inert material was used in the hypothetical slurry explosive considered in this study, the liquid explosive component (nitromethane) decomposed ahead of the solid explosive.

ACKNOWLEDGEMENT

The authors wish to express their thanks to Dr. K.K. Feng for his kind assistance throughout this work.

REFERENCES

1. C.L. Mader, "Numerical Modeling of Detonations", University of California Press, Berkeley, California, 1979.

APPENDIX A

OTHER COMPUTER CODES

The "Statement of Work" of Phase III includes:

> "A further search of a code better than the TENSOR CODE for refining the calculations with and without chemical reaction (burning process)".

Therefore, a search was carried out for this purpose. The following two computer codes appear to possess the potential of serving the purpose:

1. TOODY IV - A COMPUTER PROGRAM FOR TWO-DIMENSIONAL WAVE PROPAGATION, by J.W. Swegle, Sandia Laboratories, Albuquerque, New Mexico, September 1978.
2. HELP - A MULTI-MATERIAL EULERIAN PROGRAM FOR COMPRESSIBLE FLUID AND ELASTIC-PLASTIC FLOWS IN TWO SPACE DIMENTIONS AND TIME, by L.J. Hageman and J.M. Walsh, by Systems Science and Software, La Jolla, California, May 1971.

The TOODY IV computer code requires the storage of a number of variables for each point in the finite-difference mesh. A practical limitation on total problem size is the amount of central processor time required to complete the calculation.

The HELP computer code also requires a very large memory storage and a length central processor time. It has been stated by the authors that:

> "HELP cannot be utilized effectively without investing a considerable effort, perhaps 1 to 2 manpower for several months, in becoming familiar with the basic numerical method,

the details of the FORTRAN program, and in gaining computing experience with the code".

For these reasons, these code are mentioned here for the record. They were not adopted in the calculations of this part of the investigation.

APPENDIX B

Figures 3-35

A. Profile of deformation and pressure as a function of time in microsecond

B. Temperature-time curves for five mesh zones

C. Pressure-time curves for five mesh zones

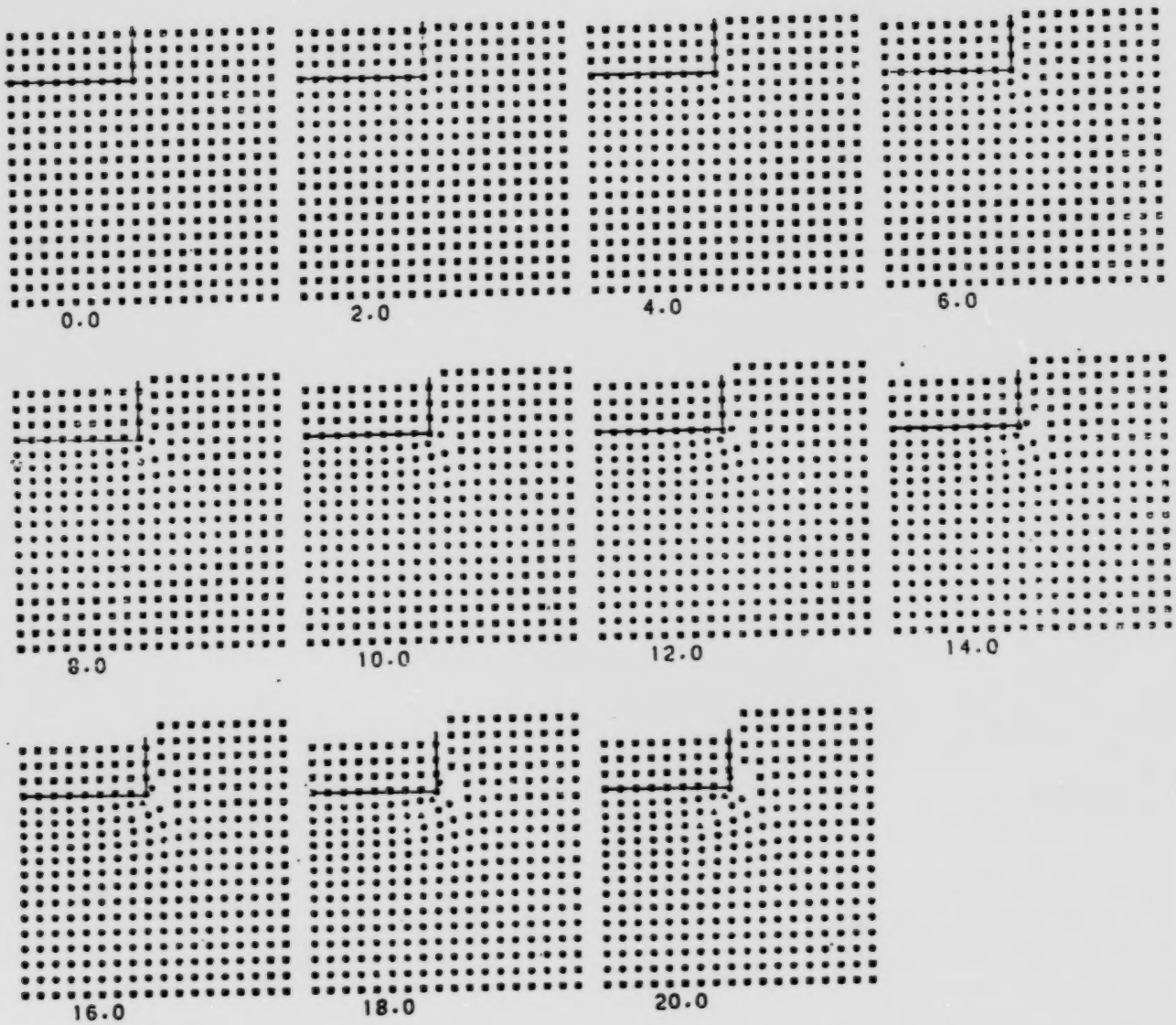

FIGURE 3A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 1)

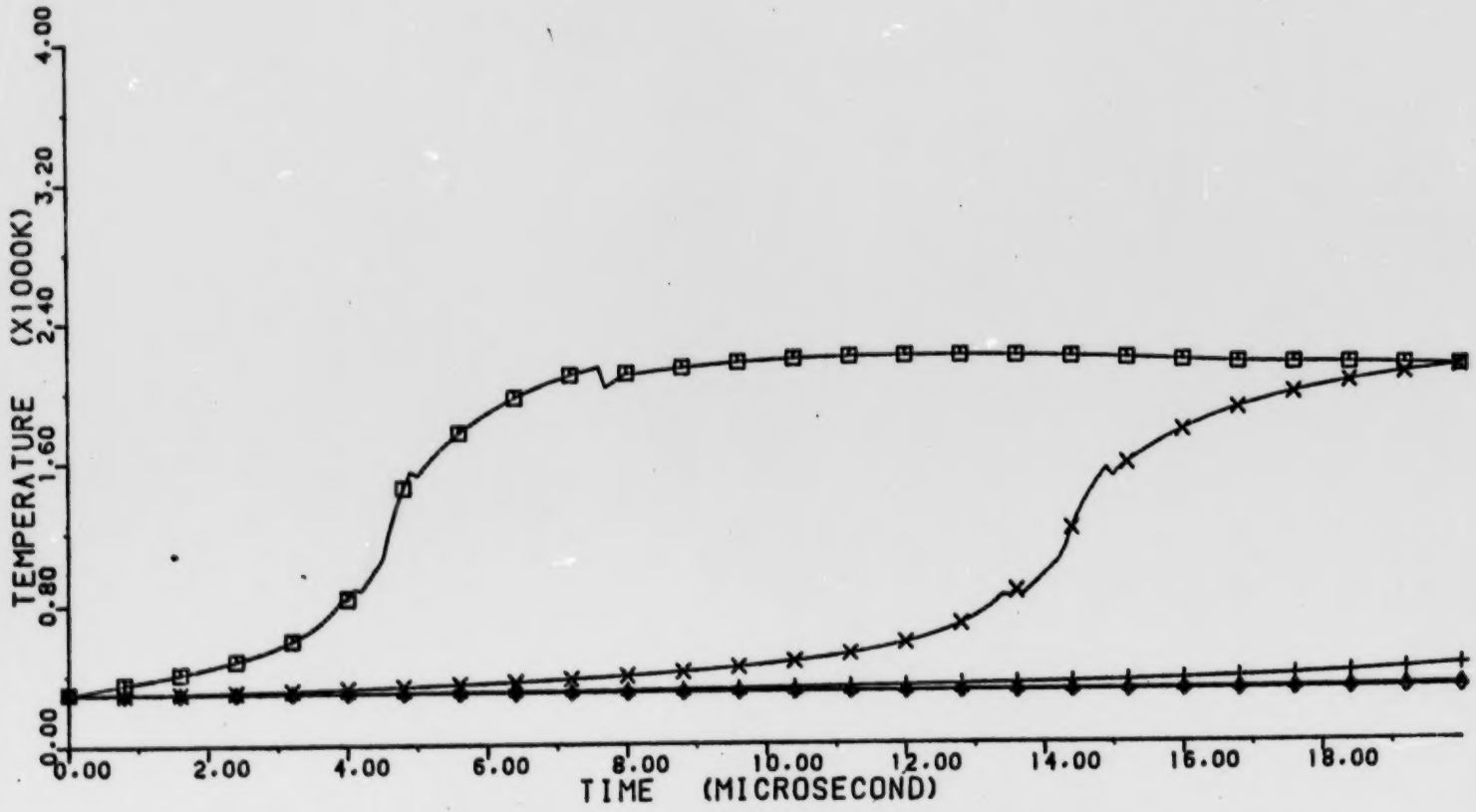

FIGURE 3B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 1)

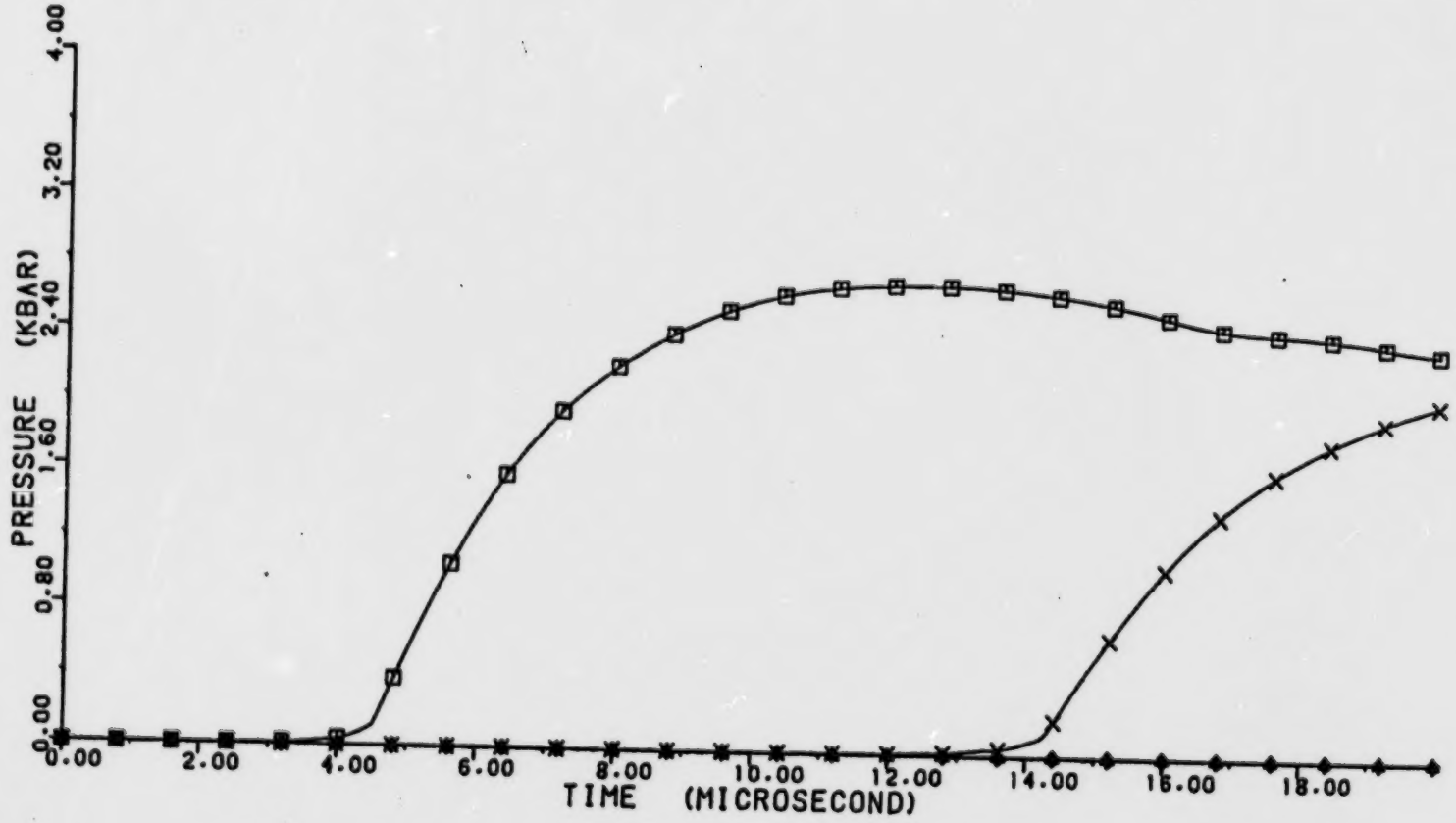

FIGURE 3C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 1)

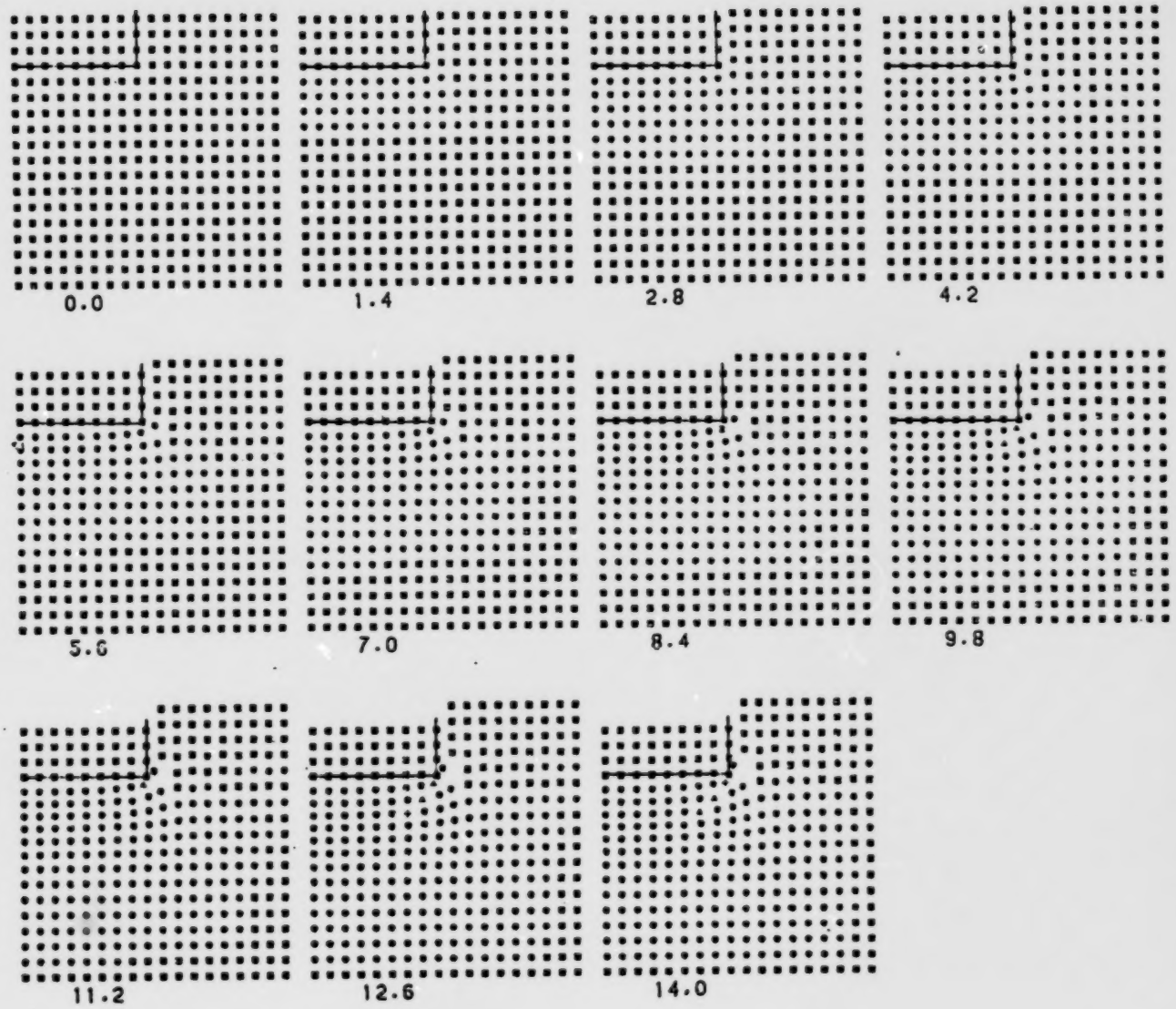

FIGURE 4A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 2)

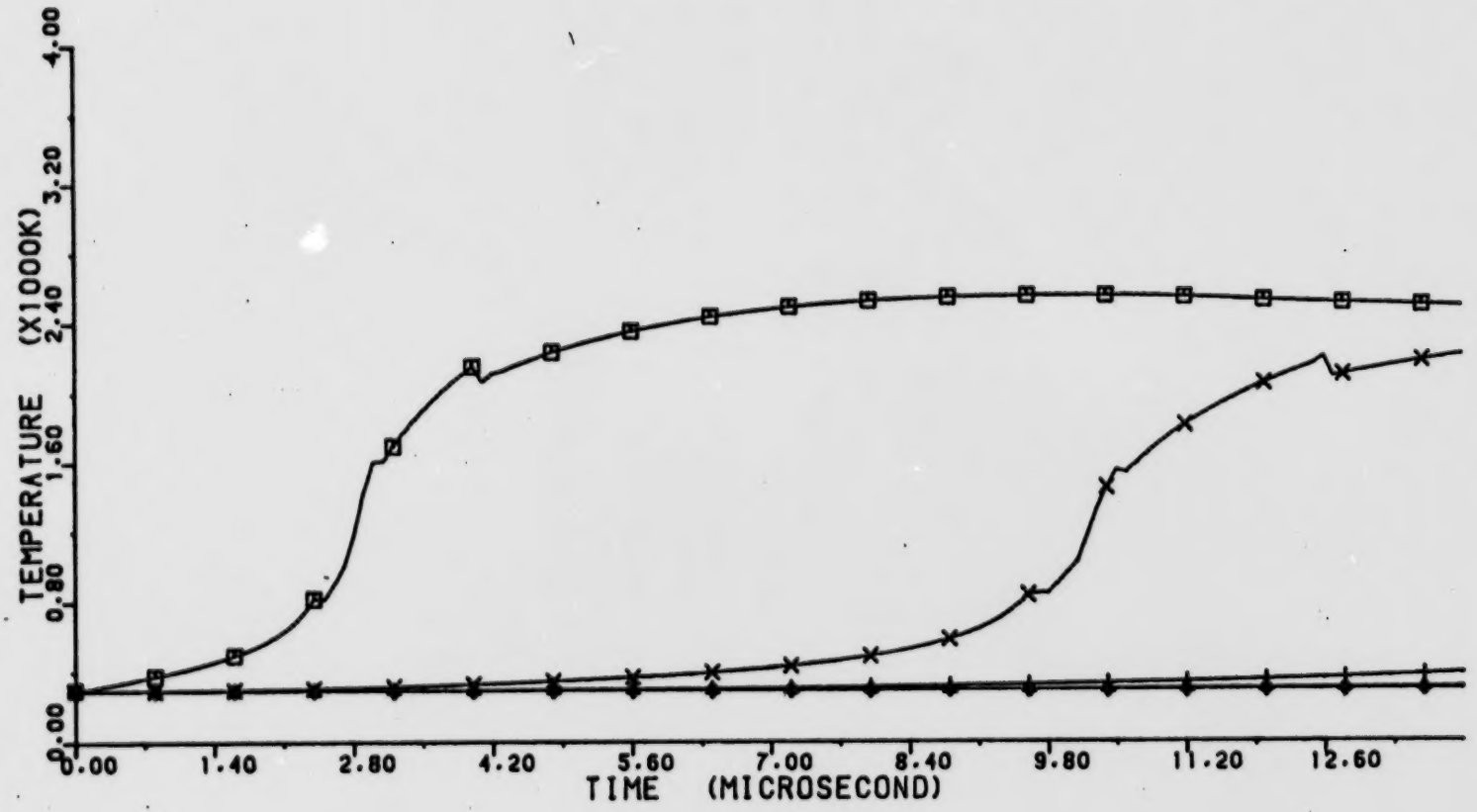

FIGURE 4B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 2)

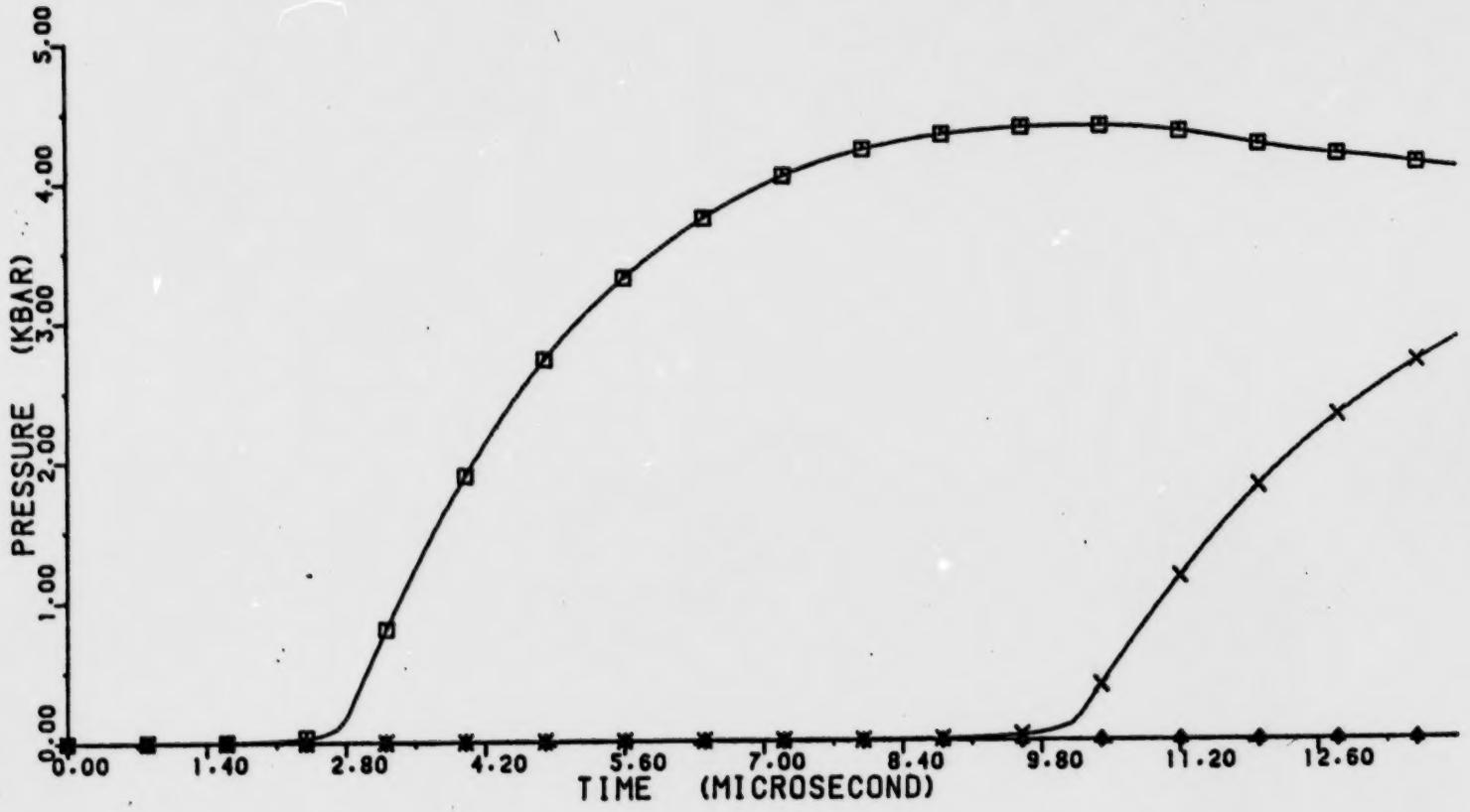

FIGURE 4C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 2)

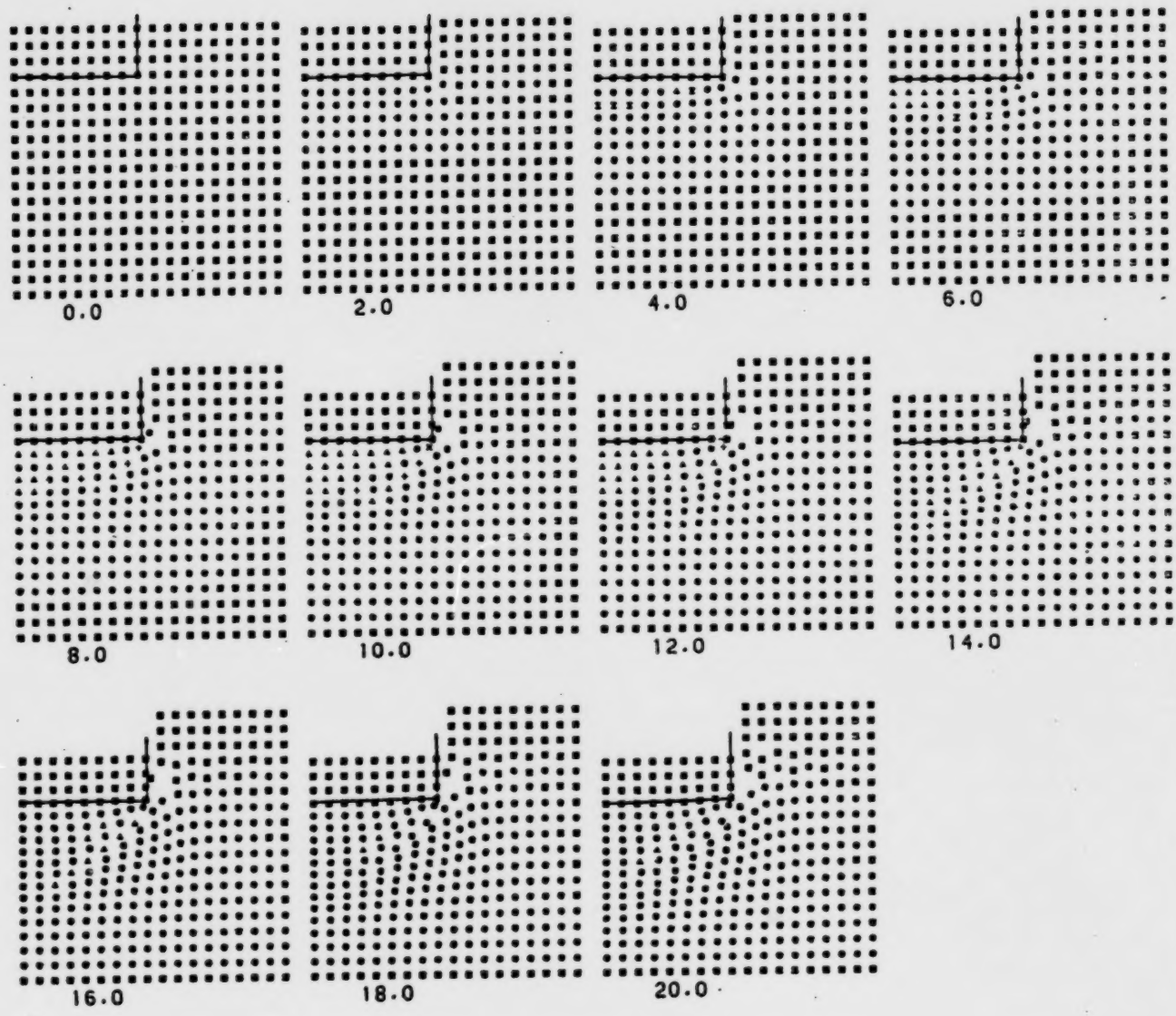

FIGURE 5A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 3)

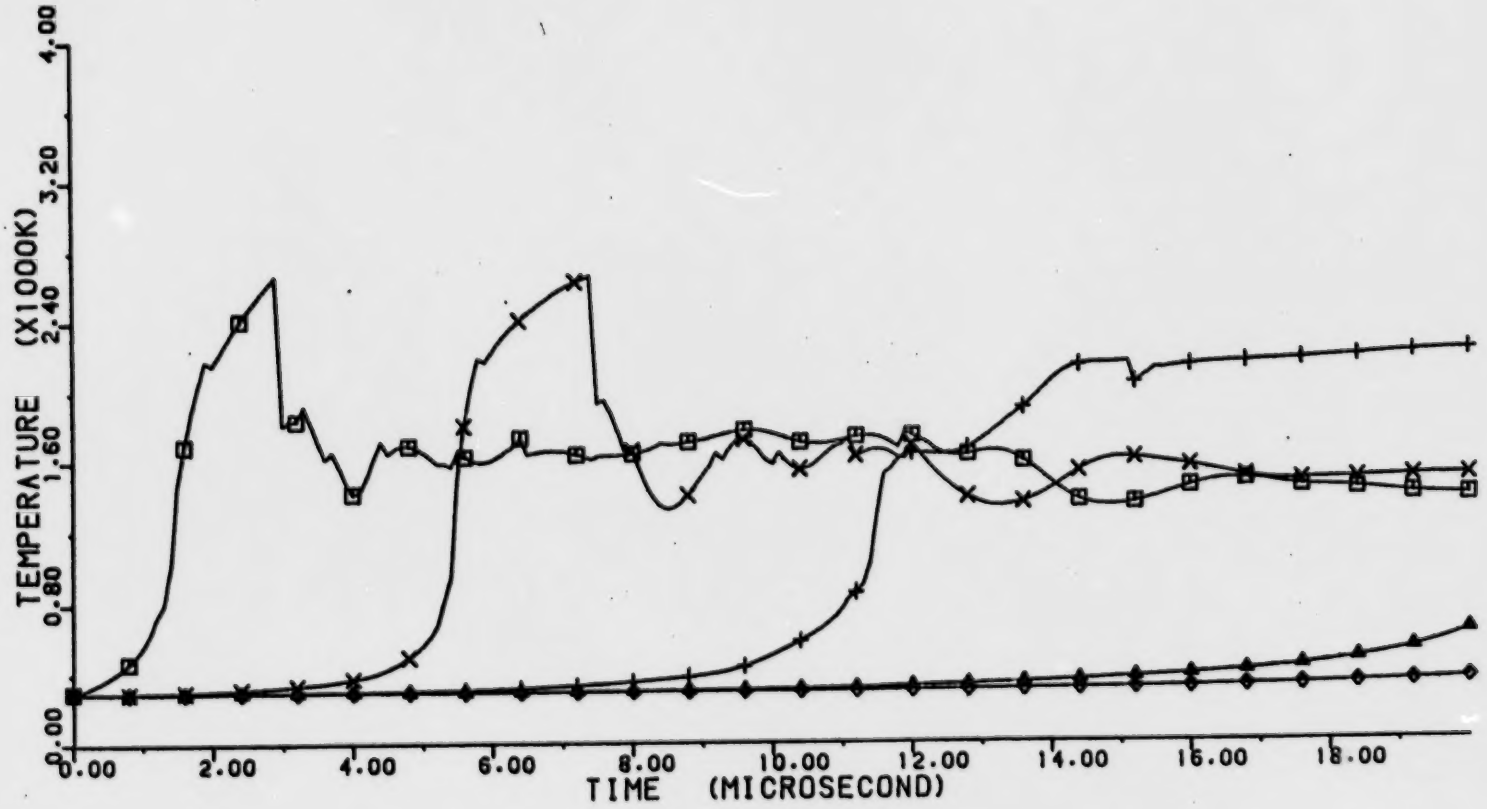

FIGURE 5B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 3)

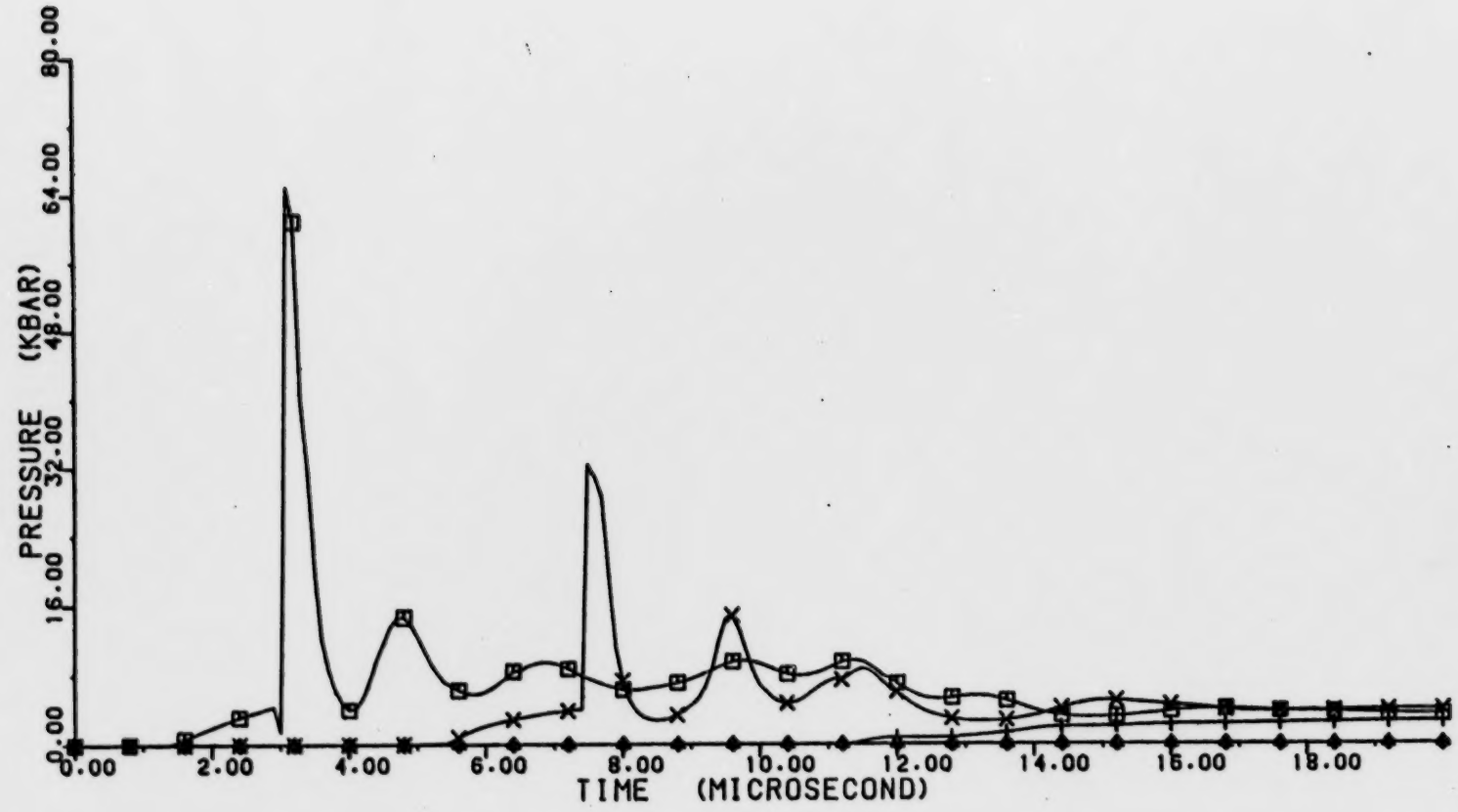

FIGURE 5C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 3)

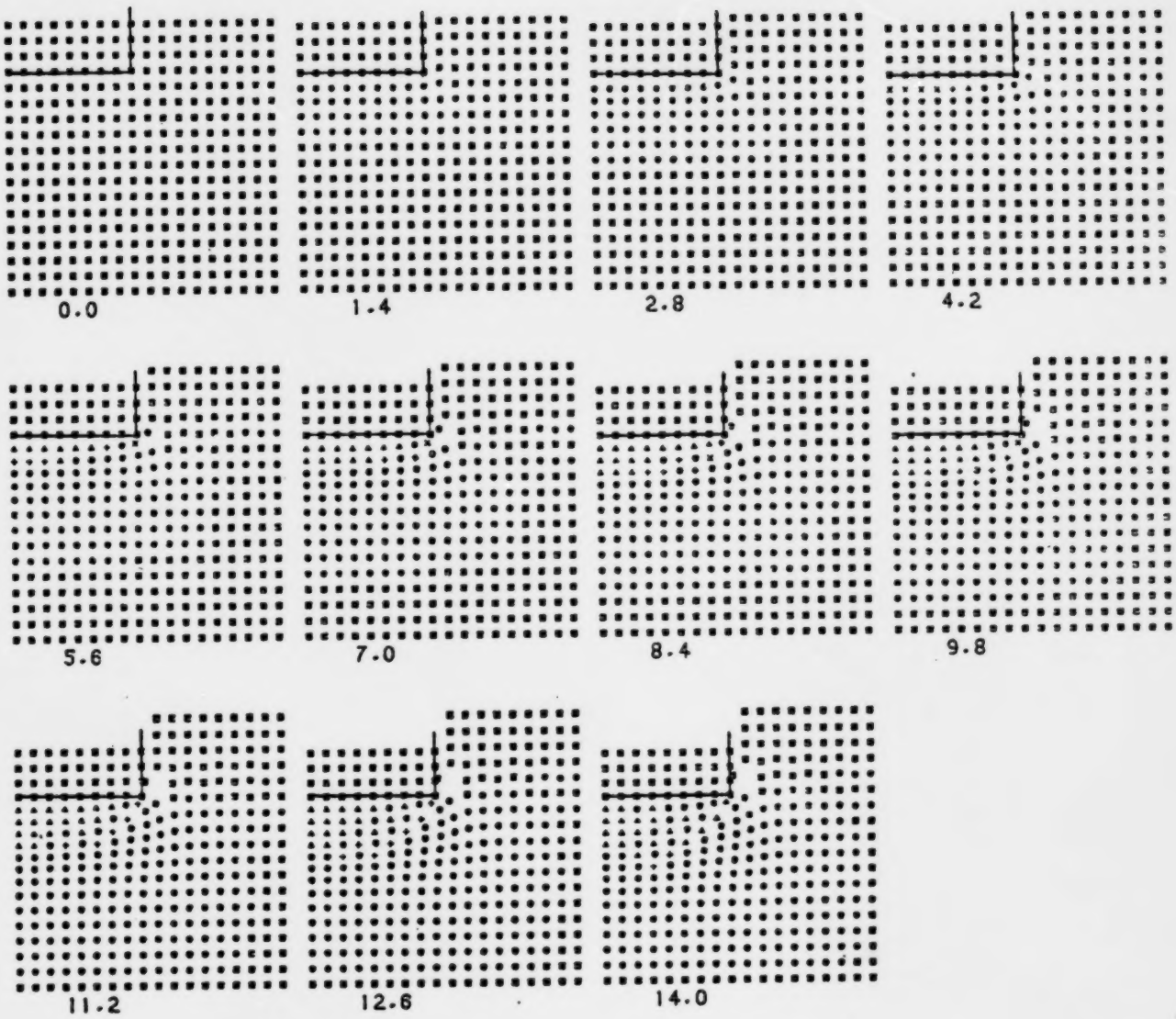

FIGURE 6A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 4)

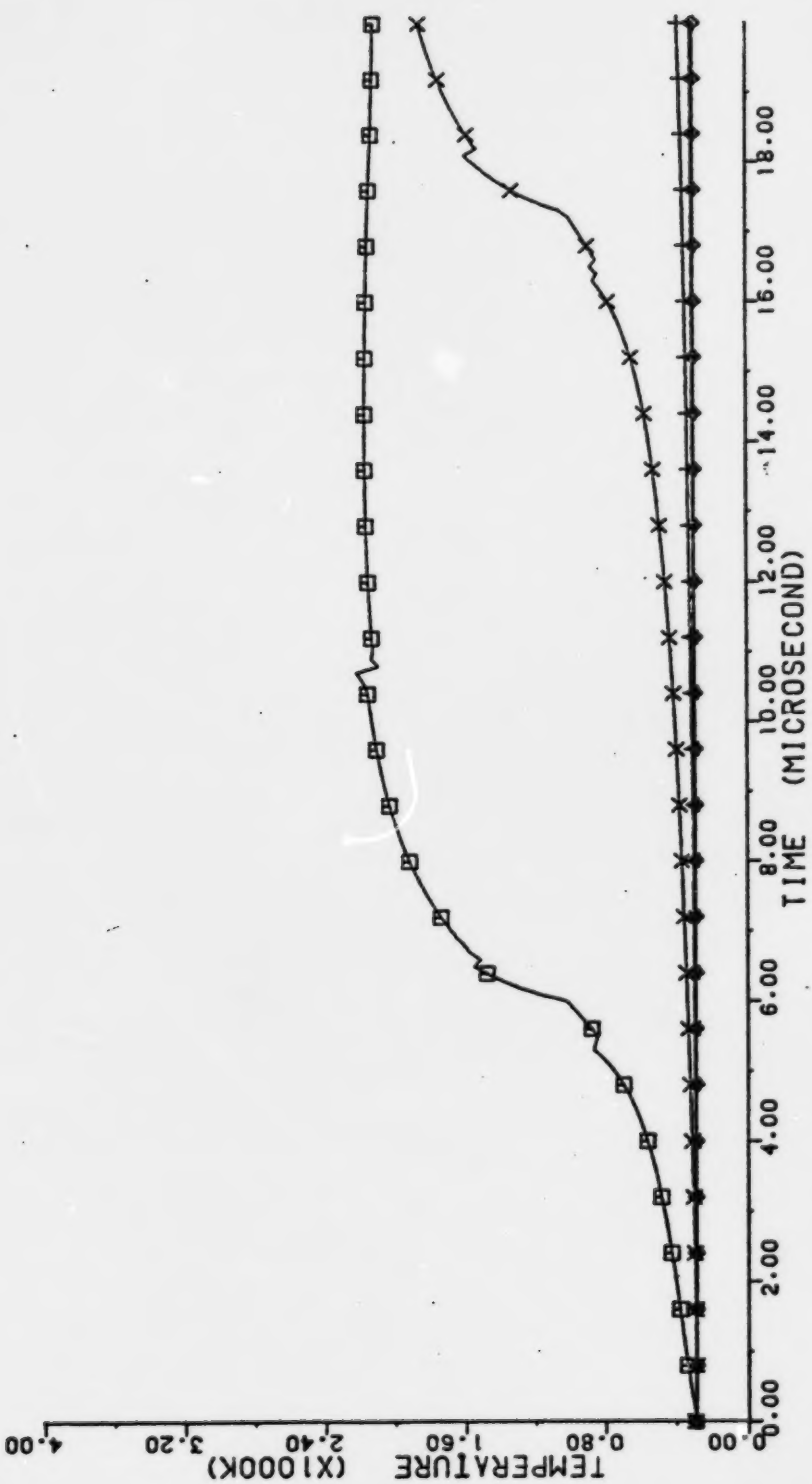

FIGURE 6B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 4)

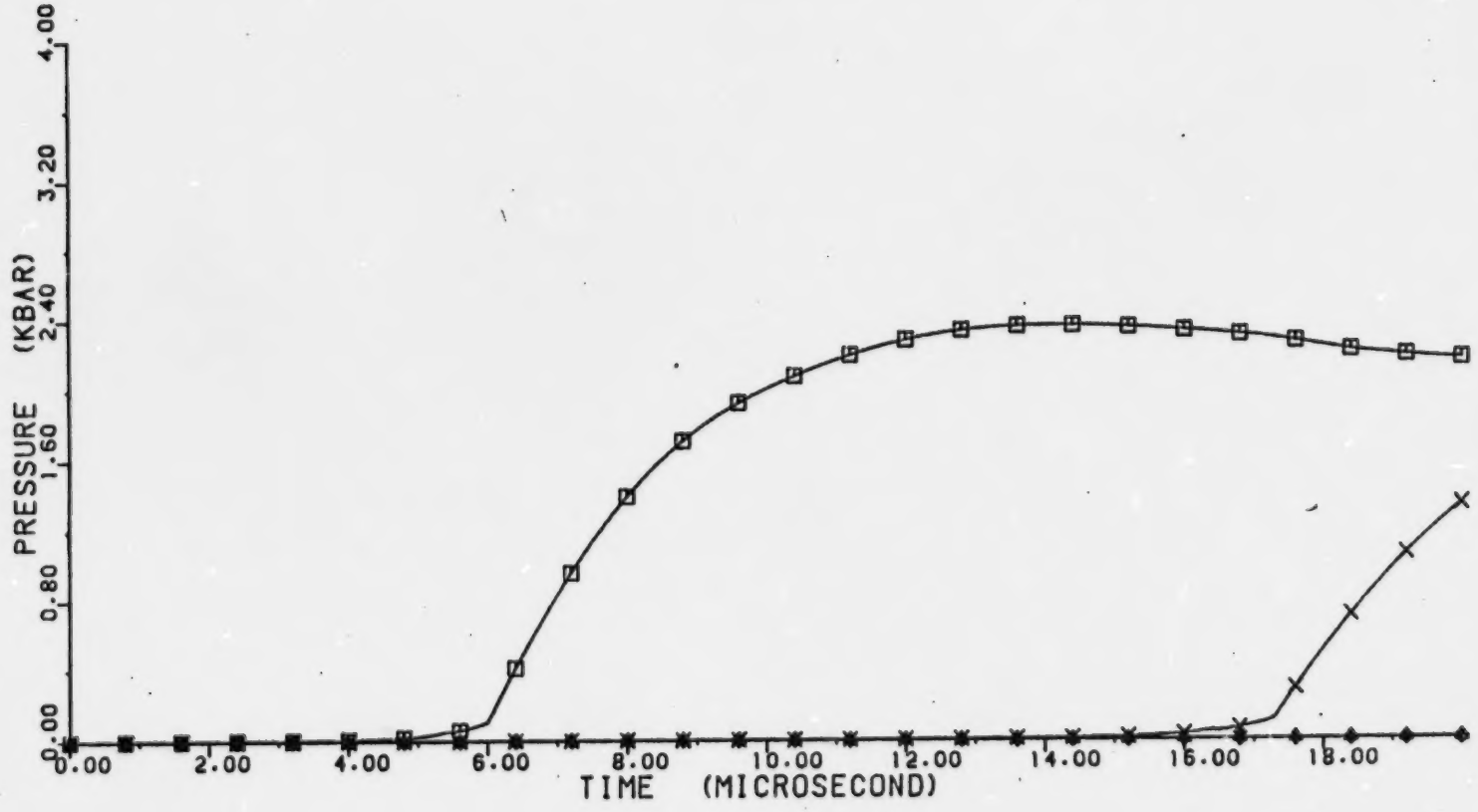

FIGURE 6C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 4)

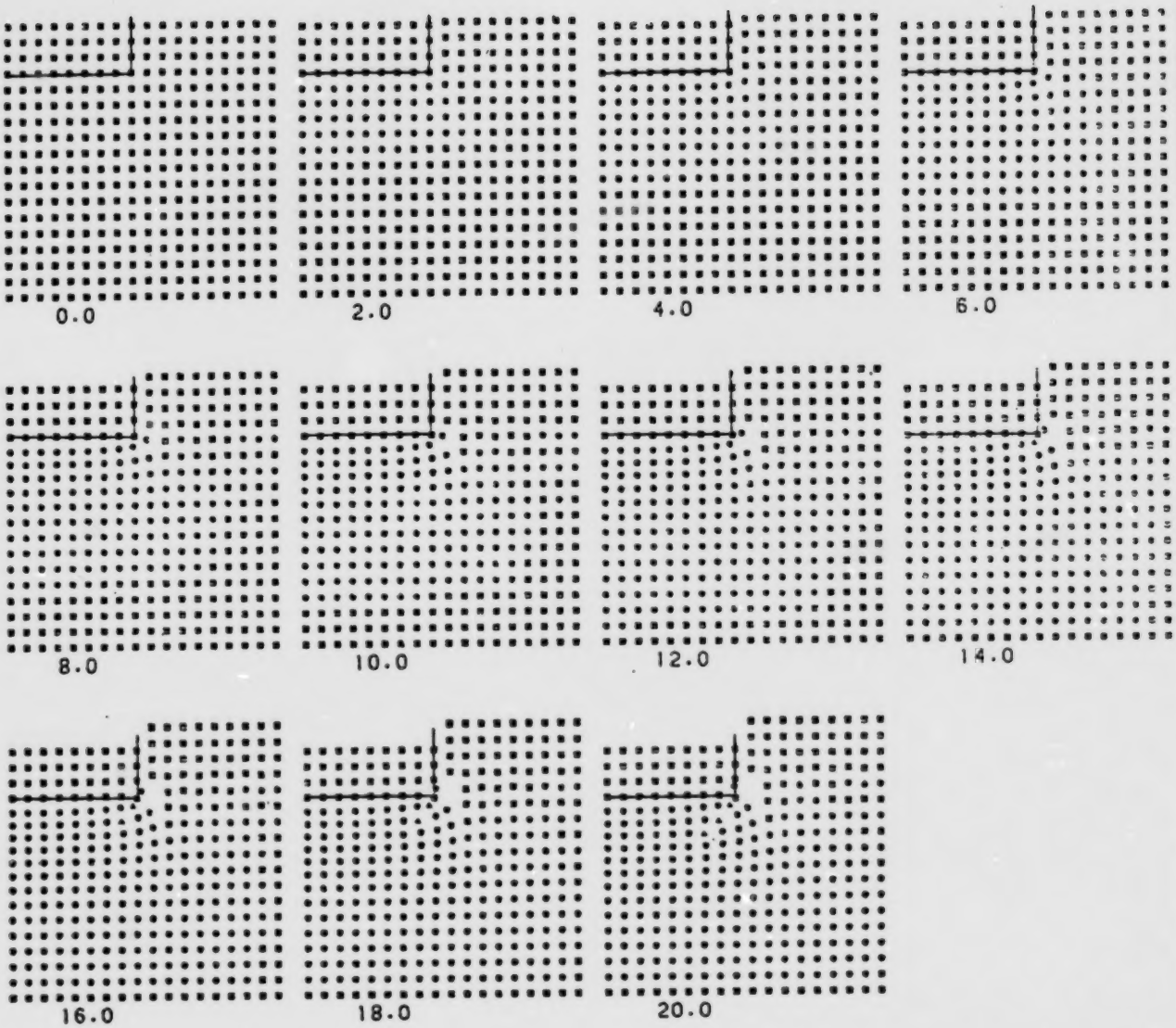

FIGURE 7A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 5)

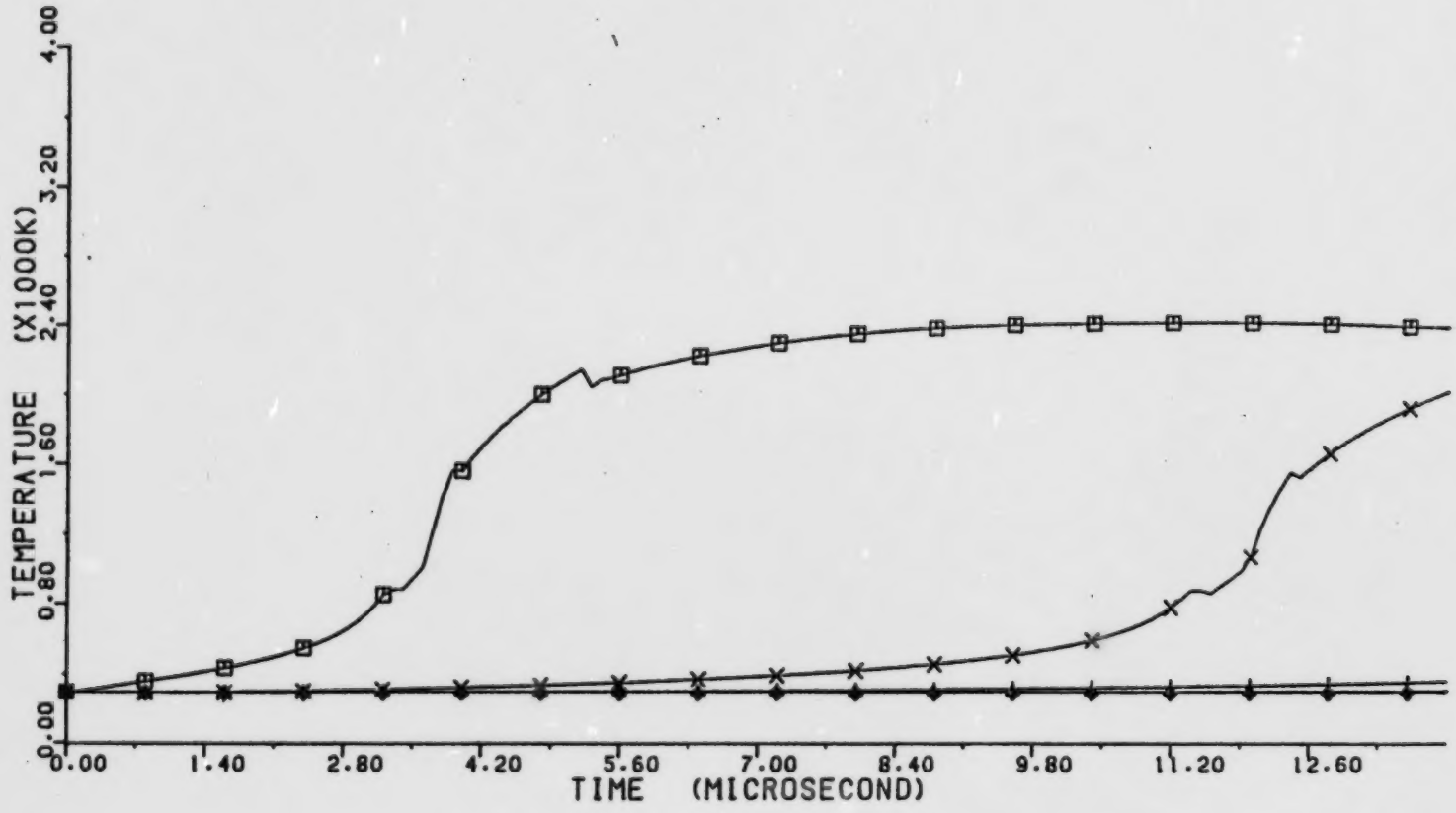

FIGURE 7B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 5)

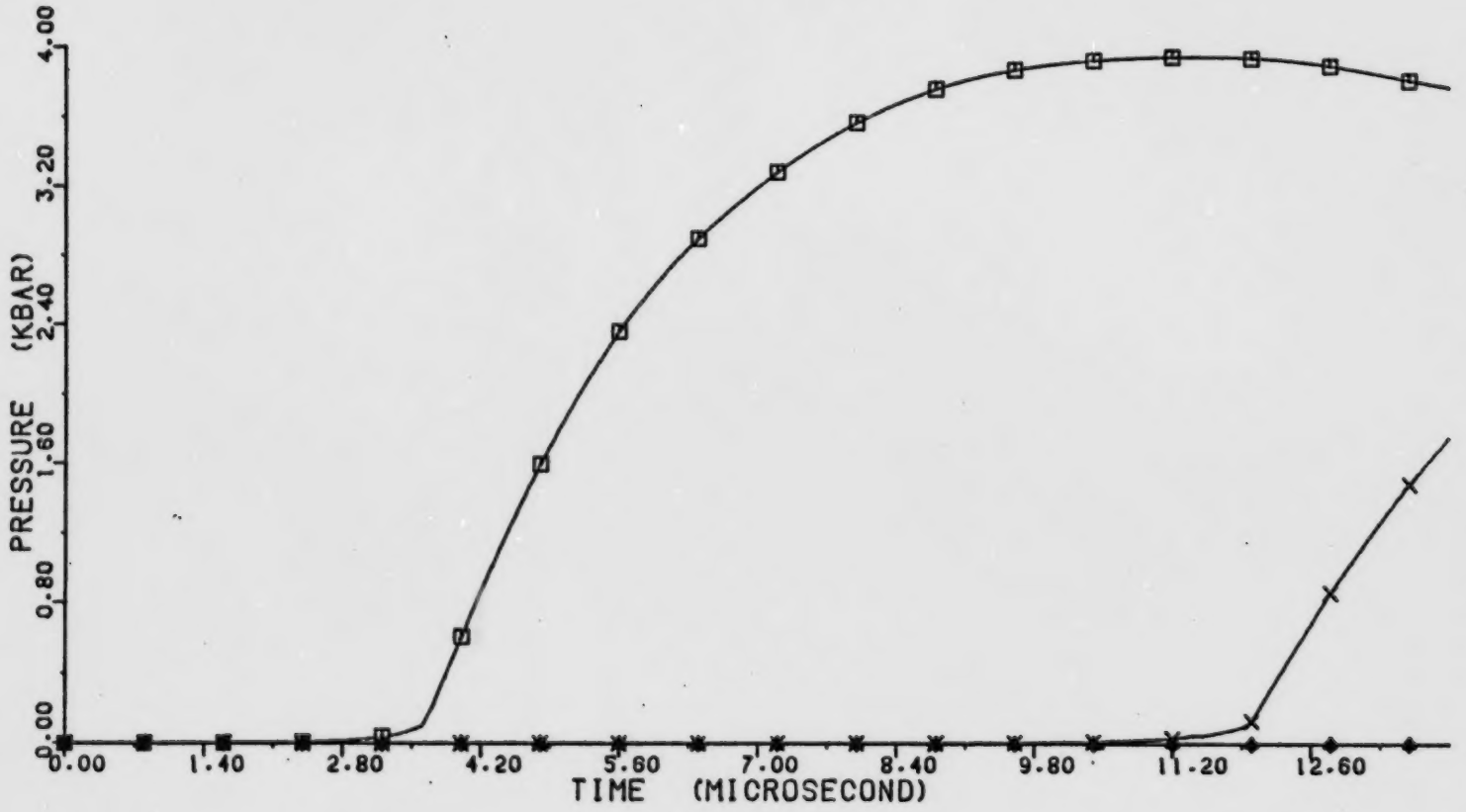

FIGURE 7C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 5)

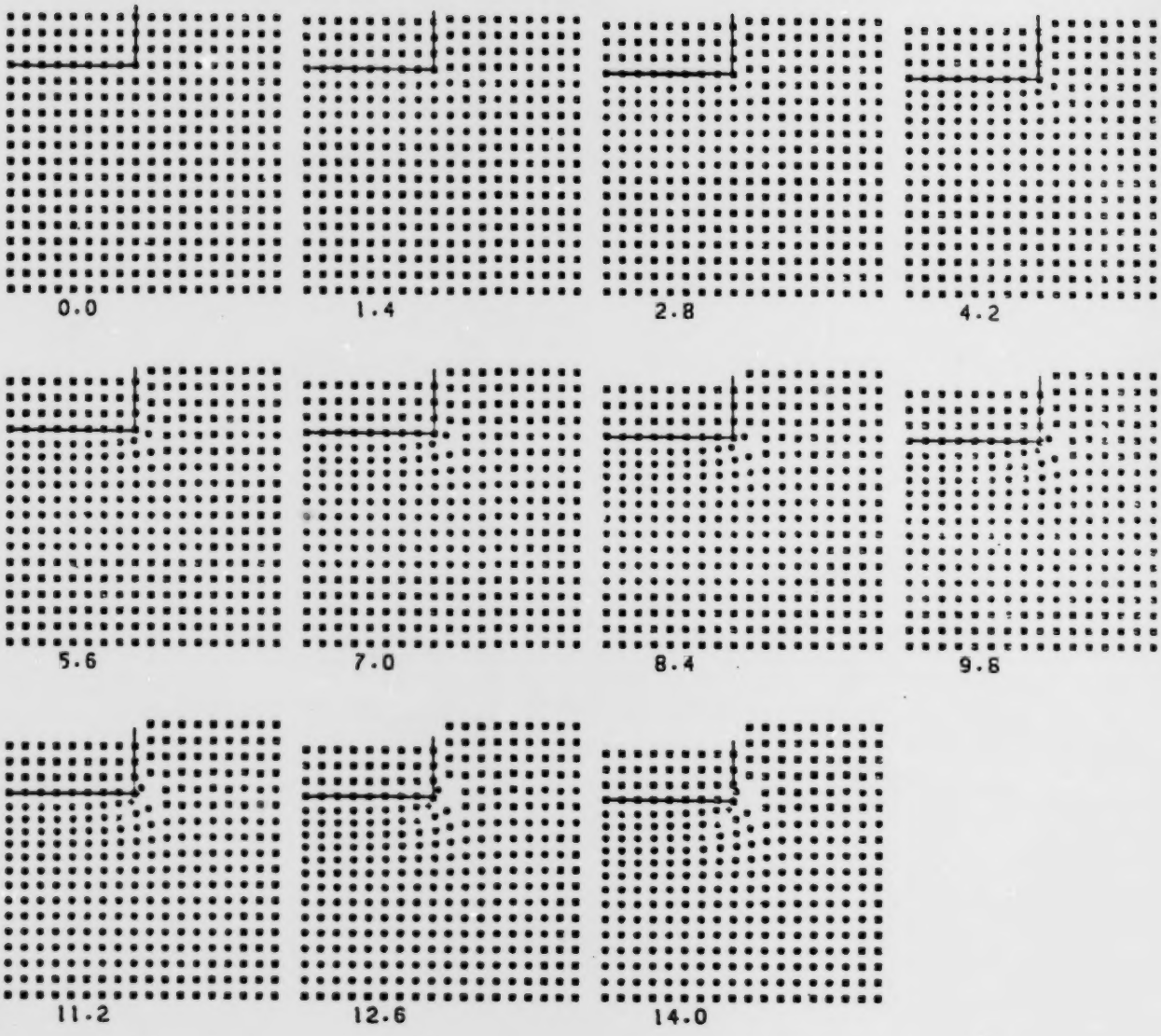

FIGURE 8A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 6)

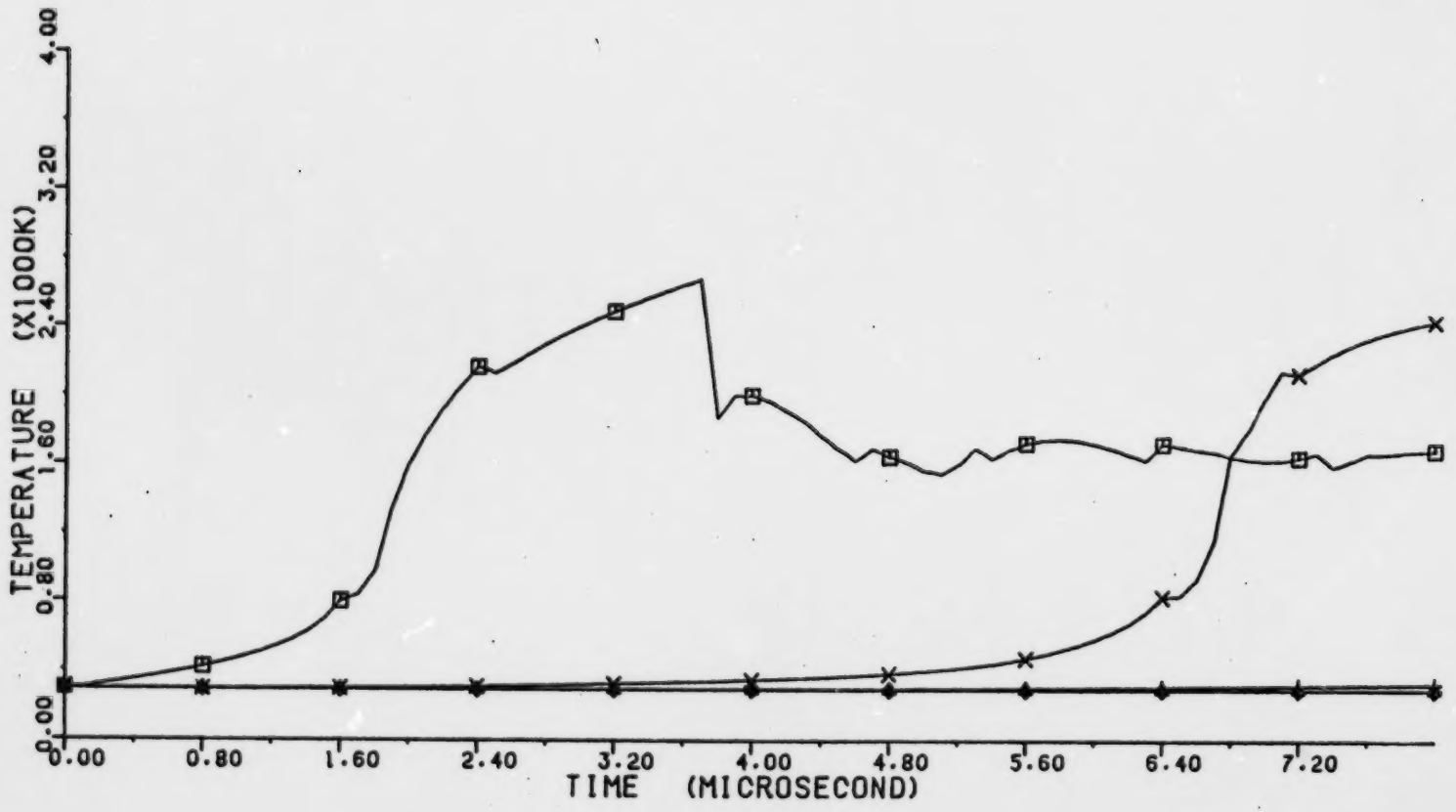

FIGURE 8B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 6)

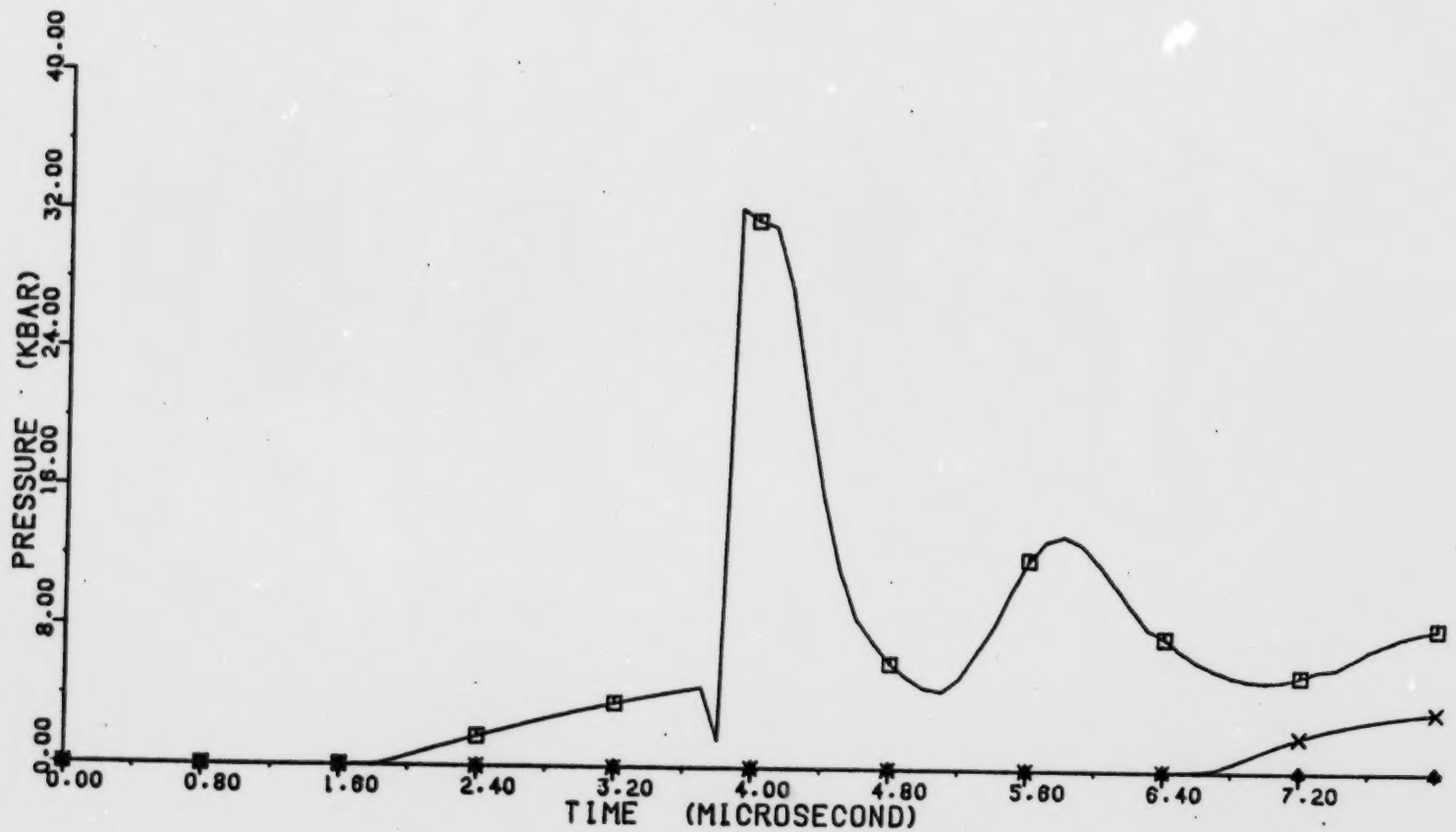

FIGURE 8C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 6)

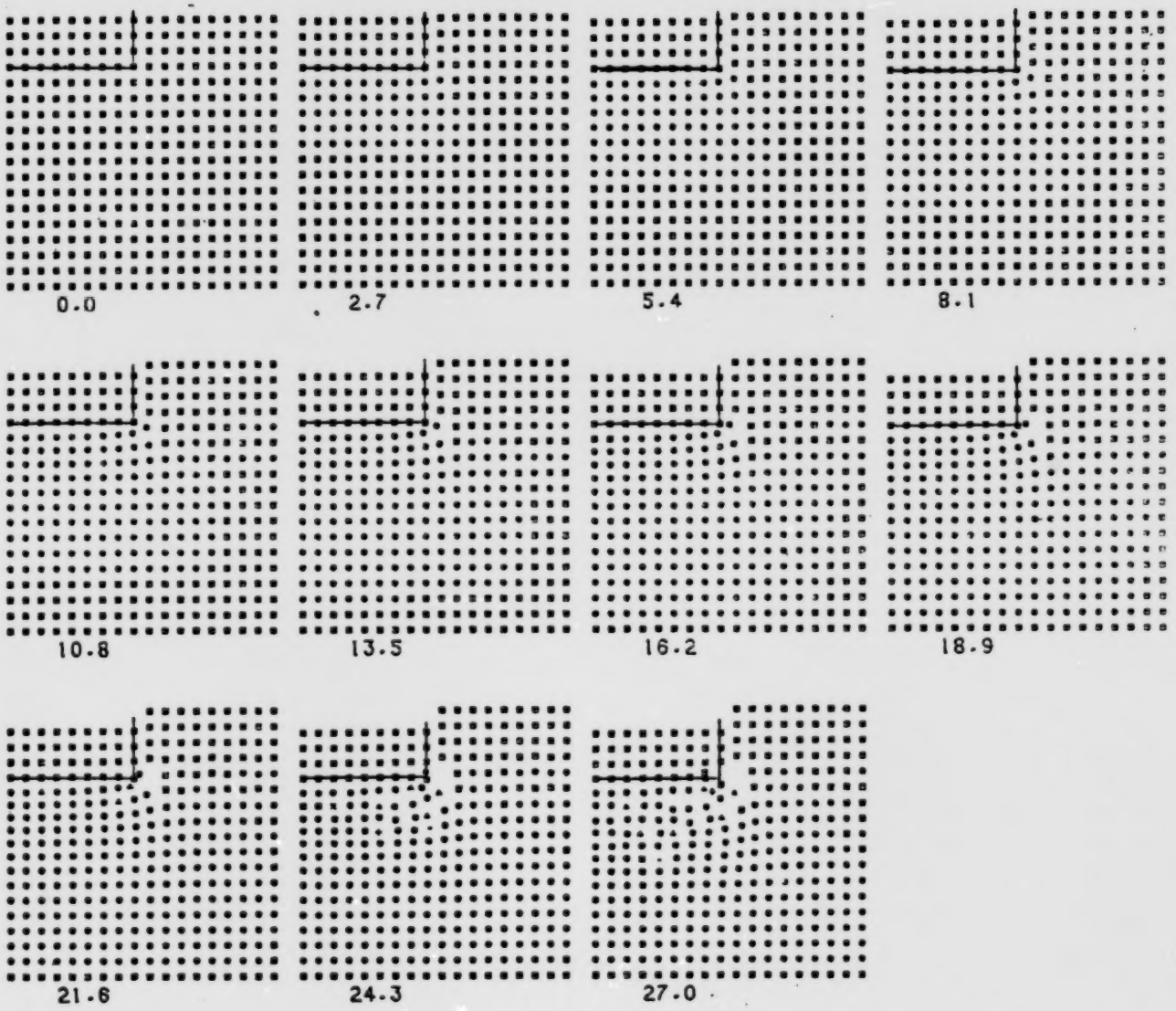

FIGURE 9A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 7)

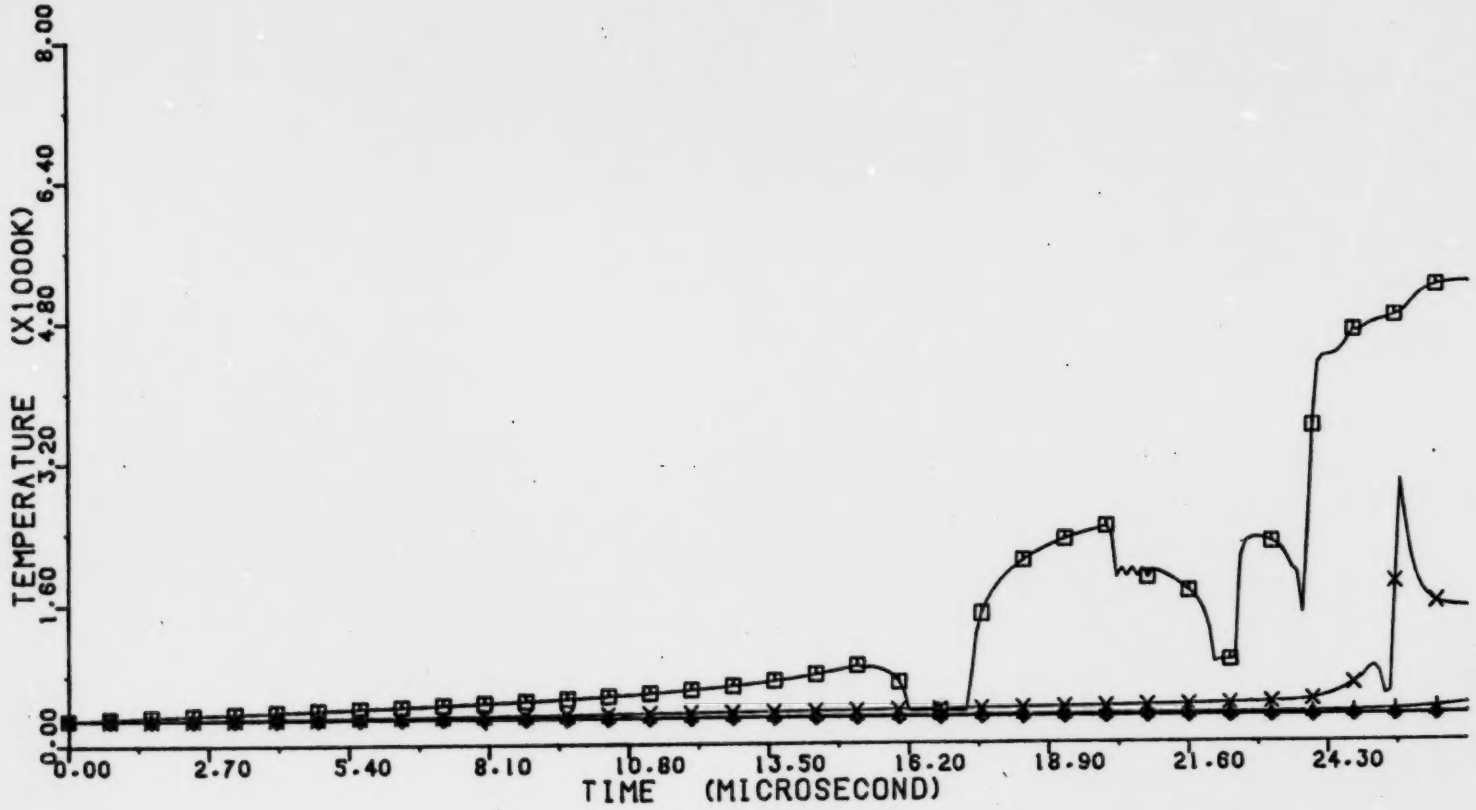

FIGURE 9B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 7)

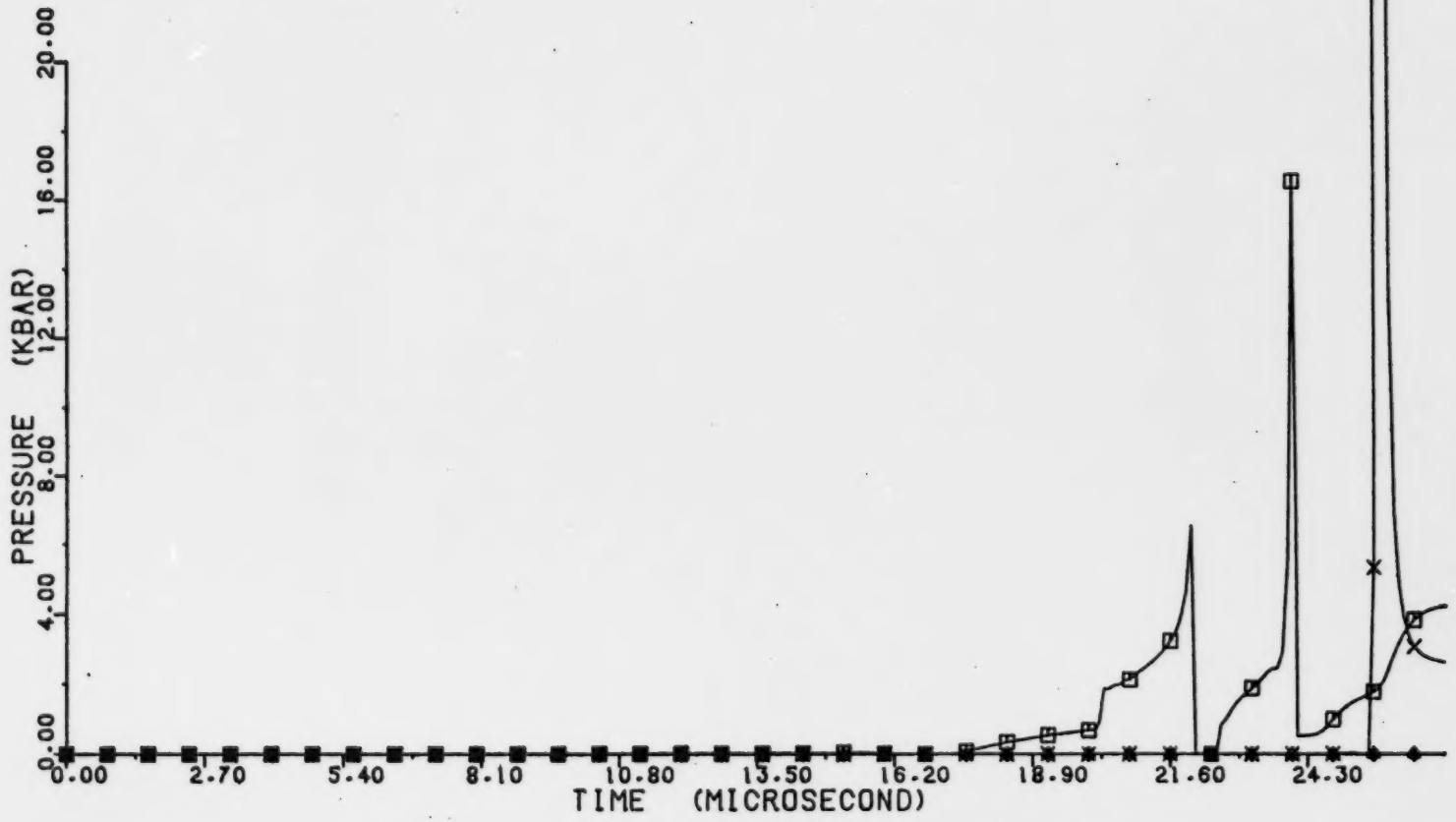

FIGURE 9C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 7)

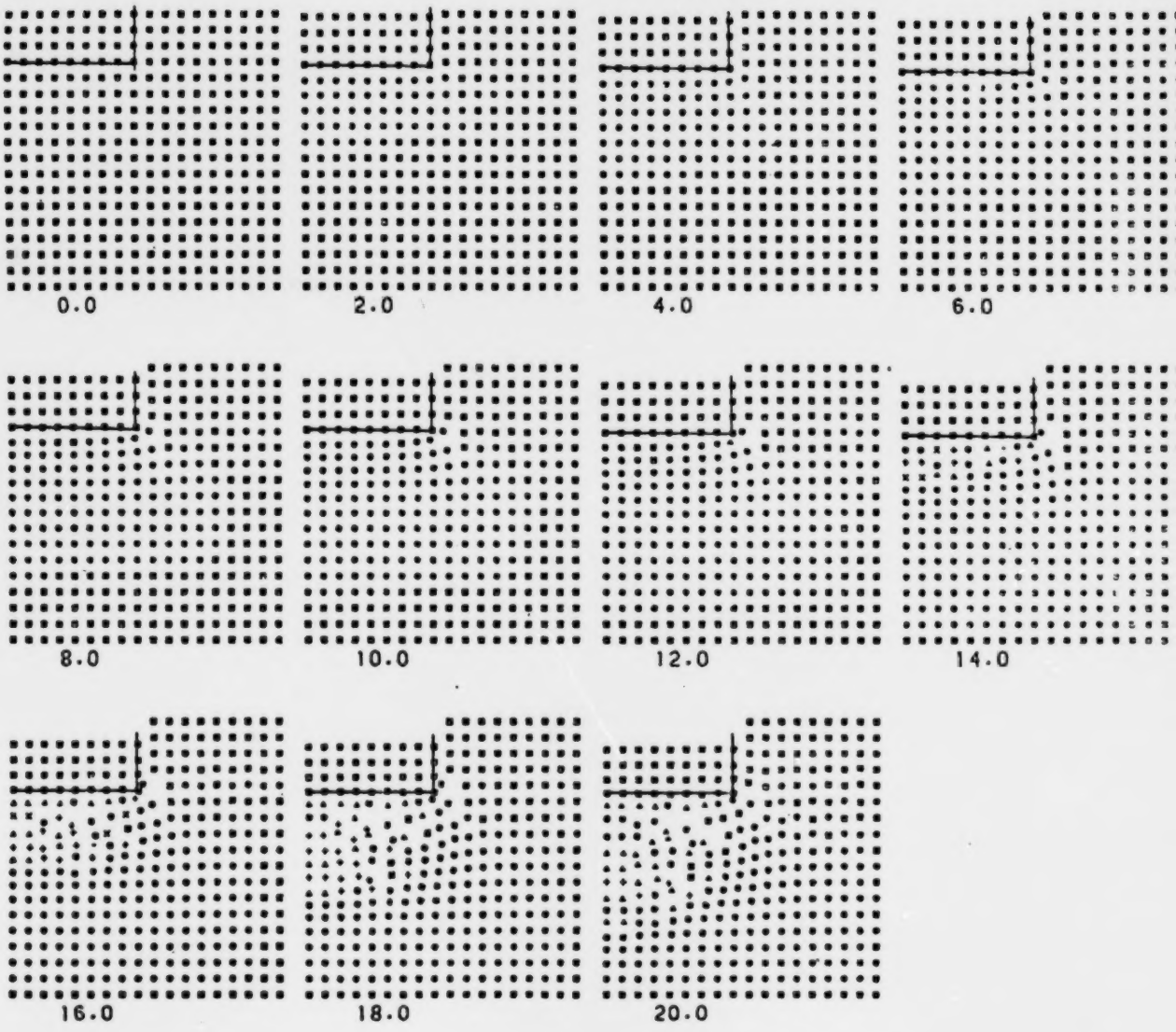

FIGURE 10A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 8)

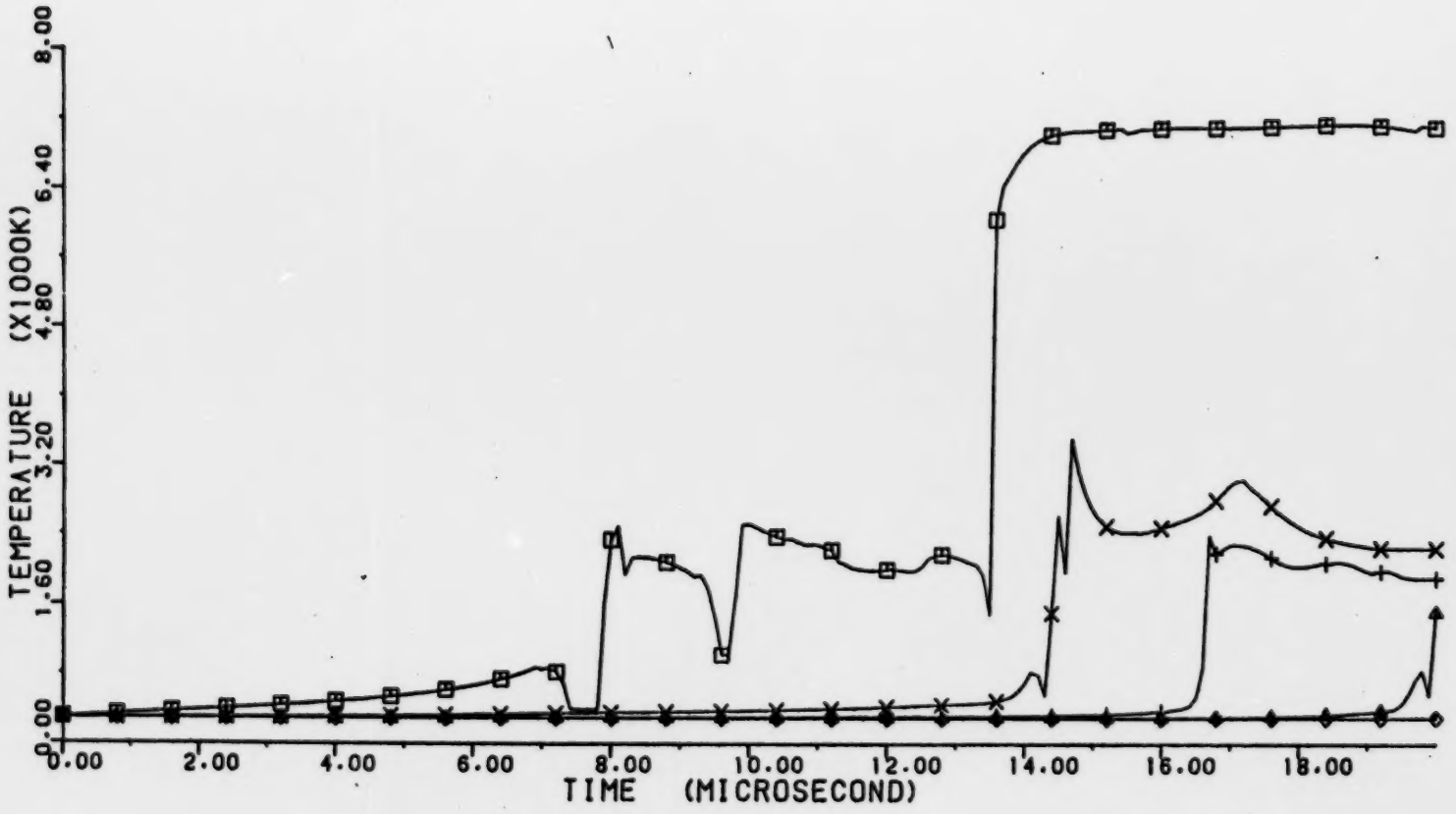

FIGURE 10B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 8)

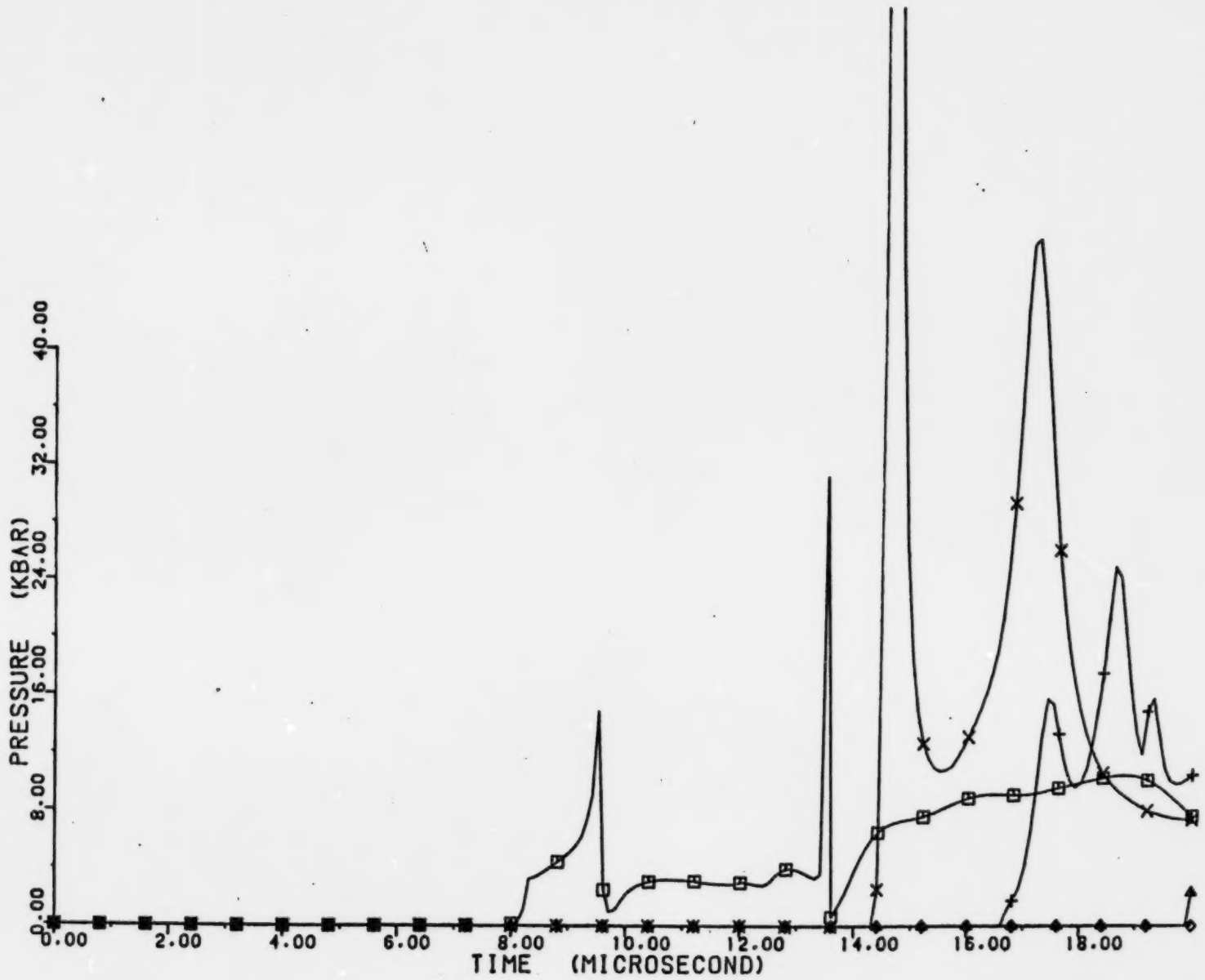

FIGURE 10C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 8)

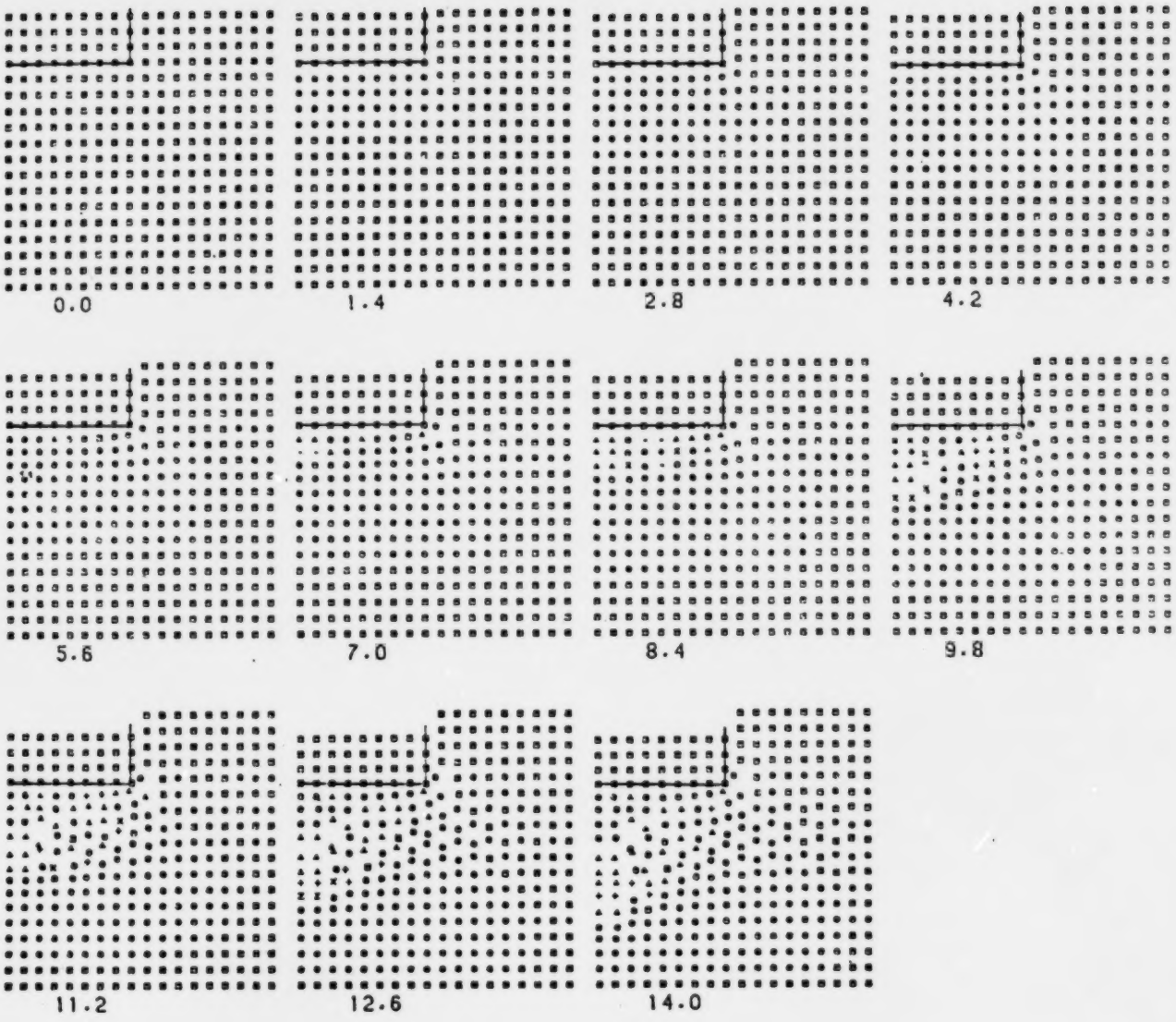

FIGURE 11A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 9)

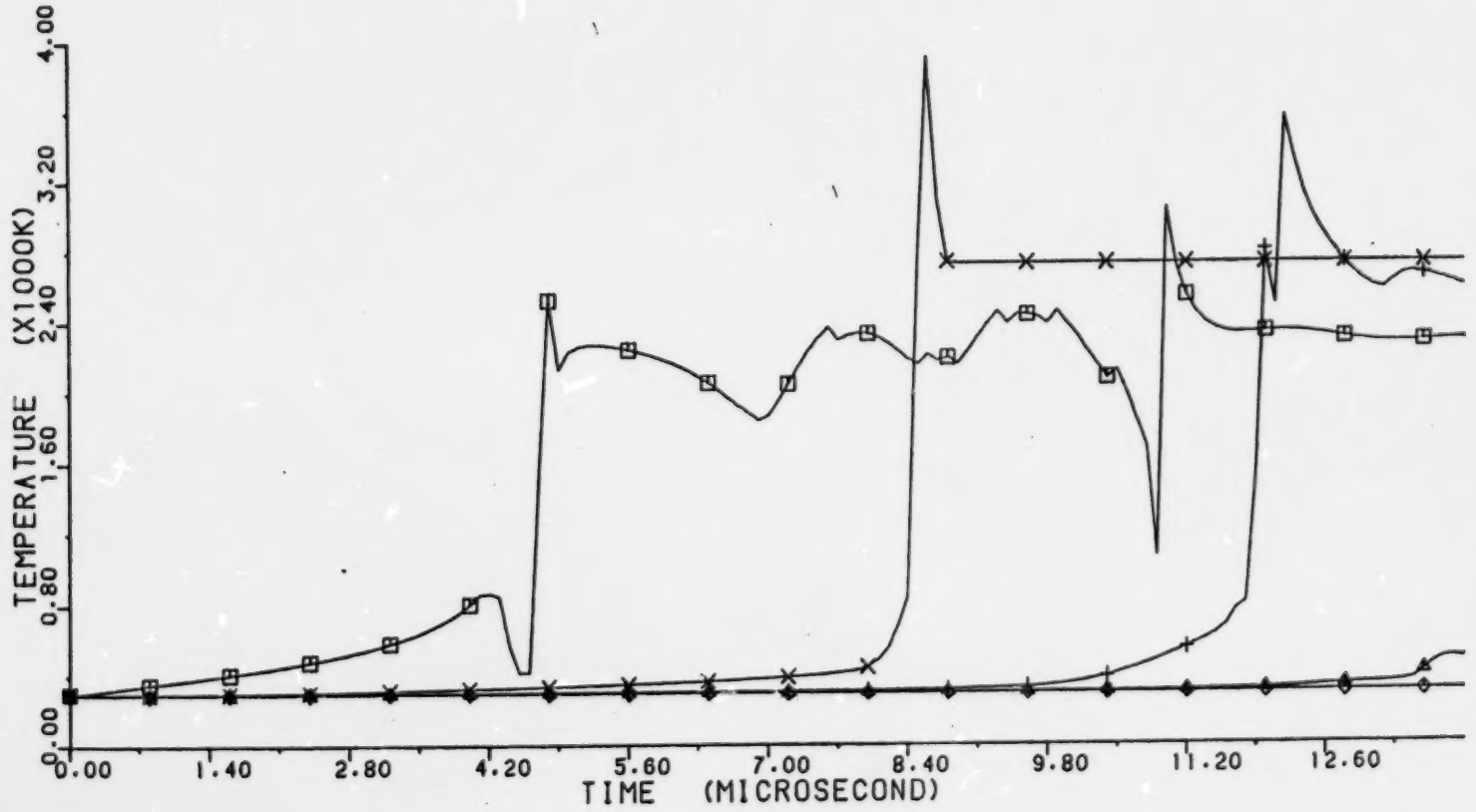

FIGURE 11B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 9)

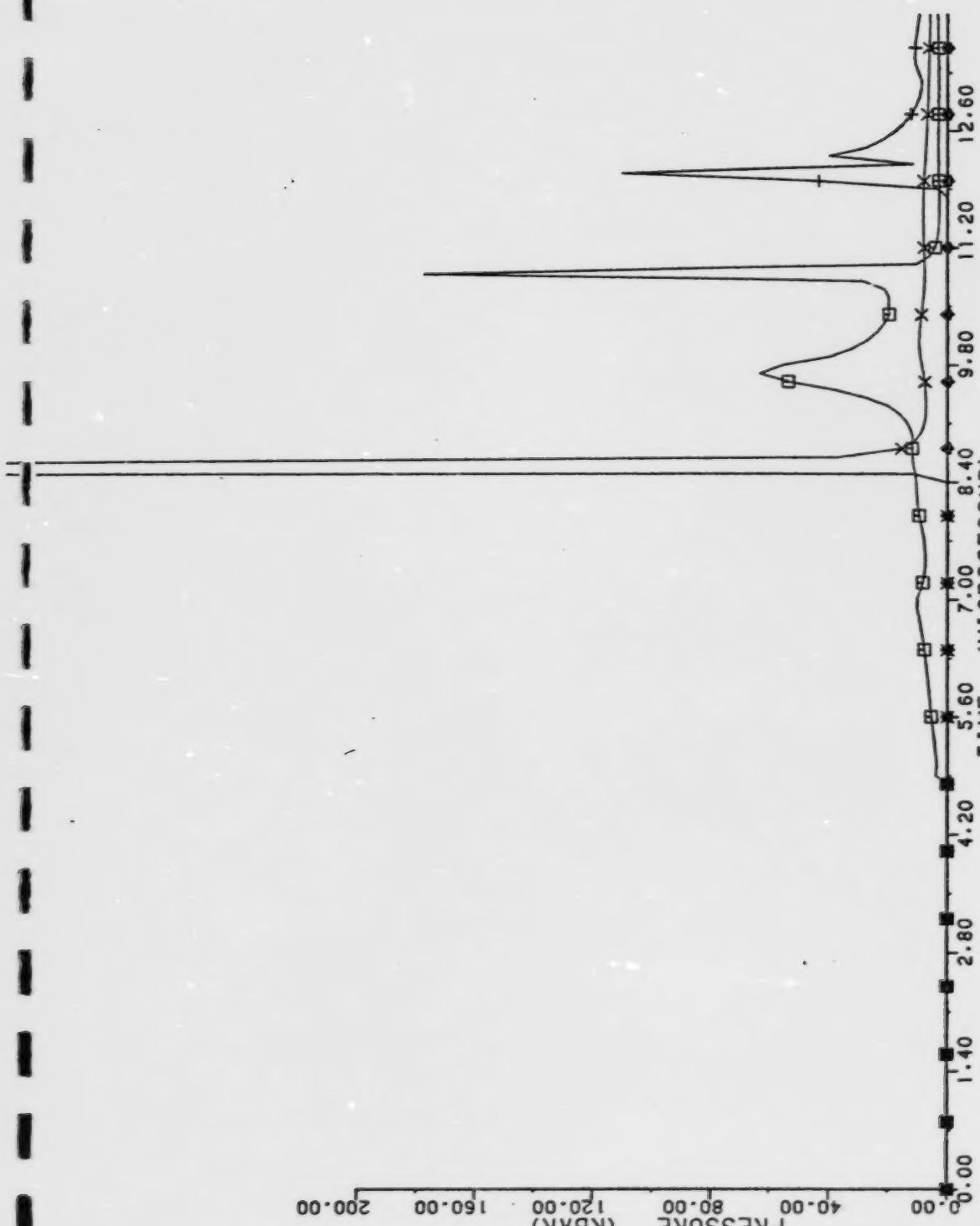

FIGURE 11C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 9)

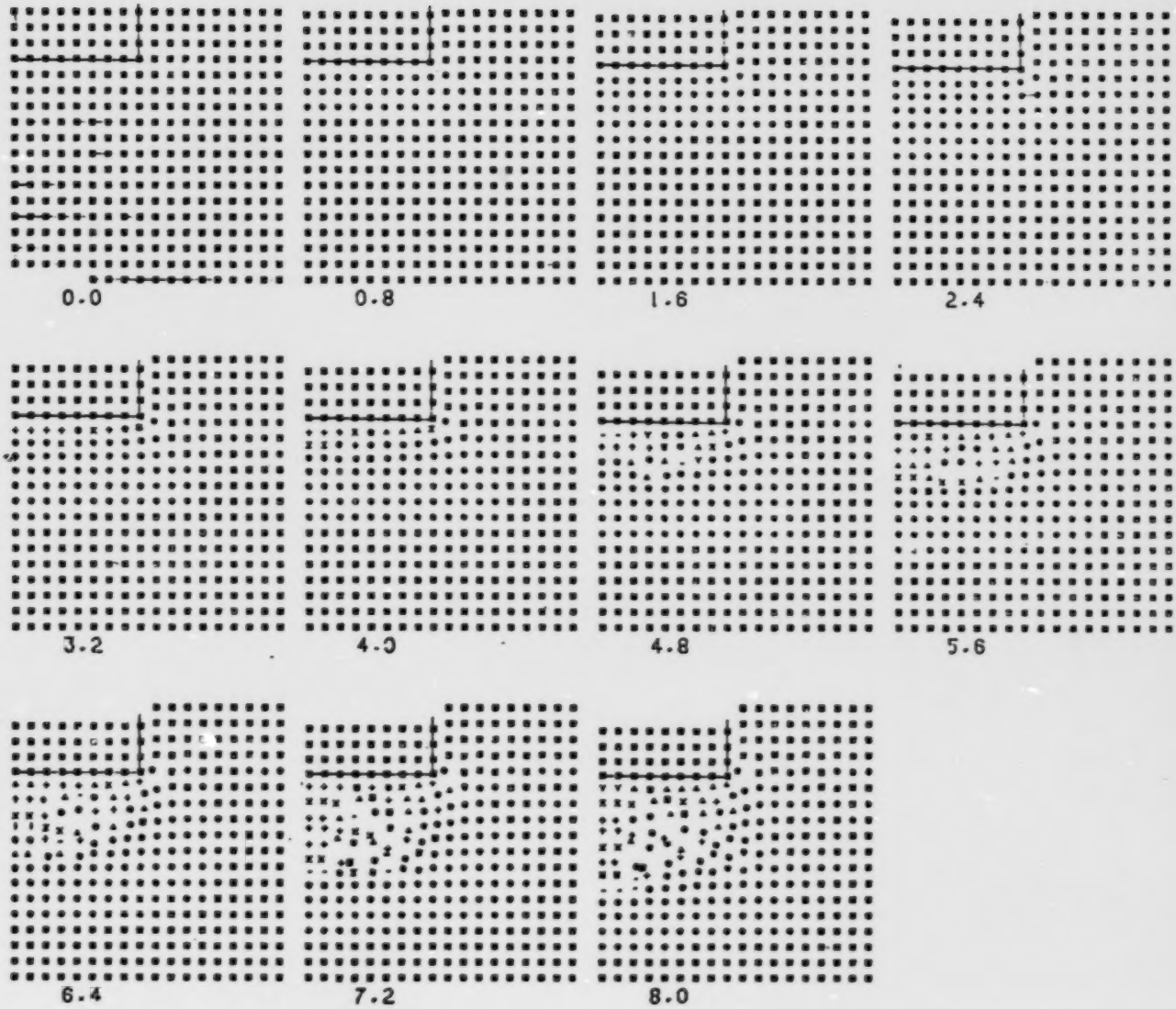

FIGURE 12A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 10)

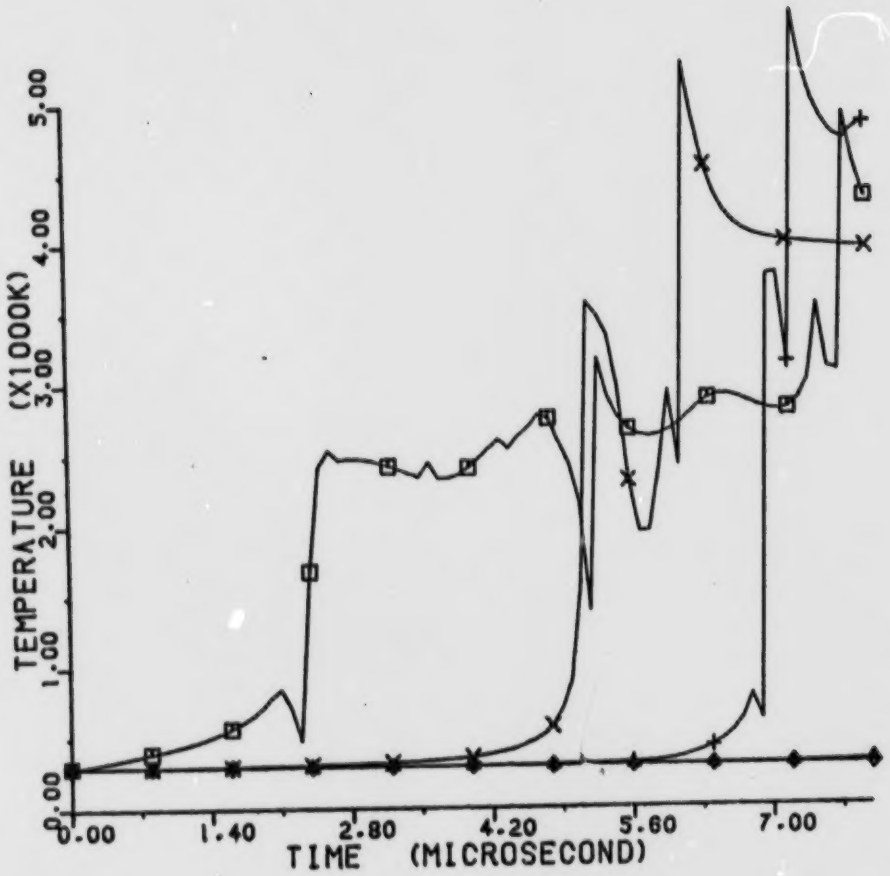

FIGURE 12B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 10)

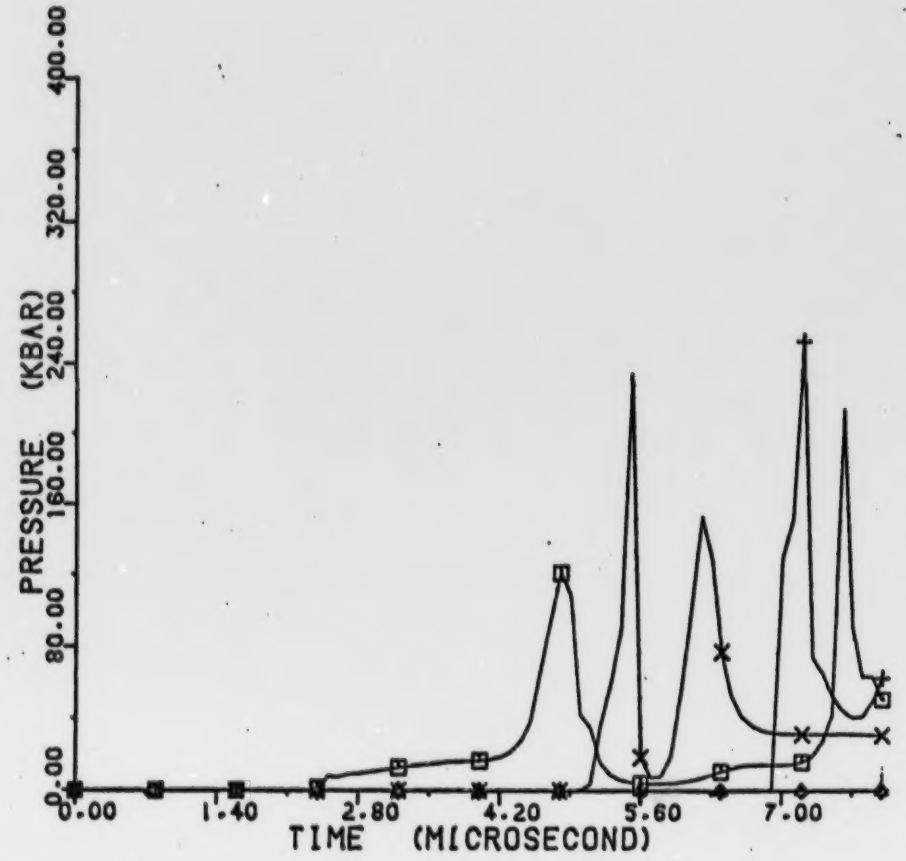

FIGURE 12C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 10)

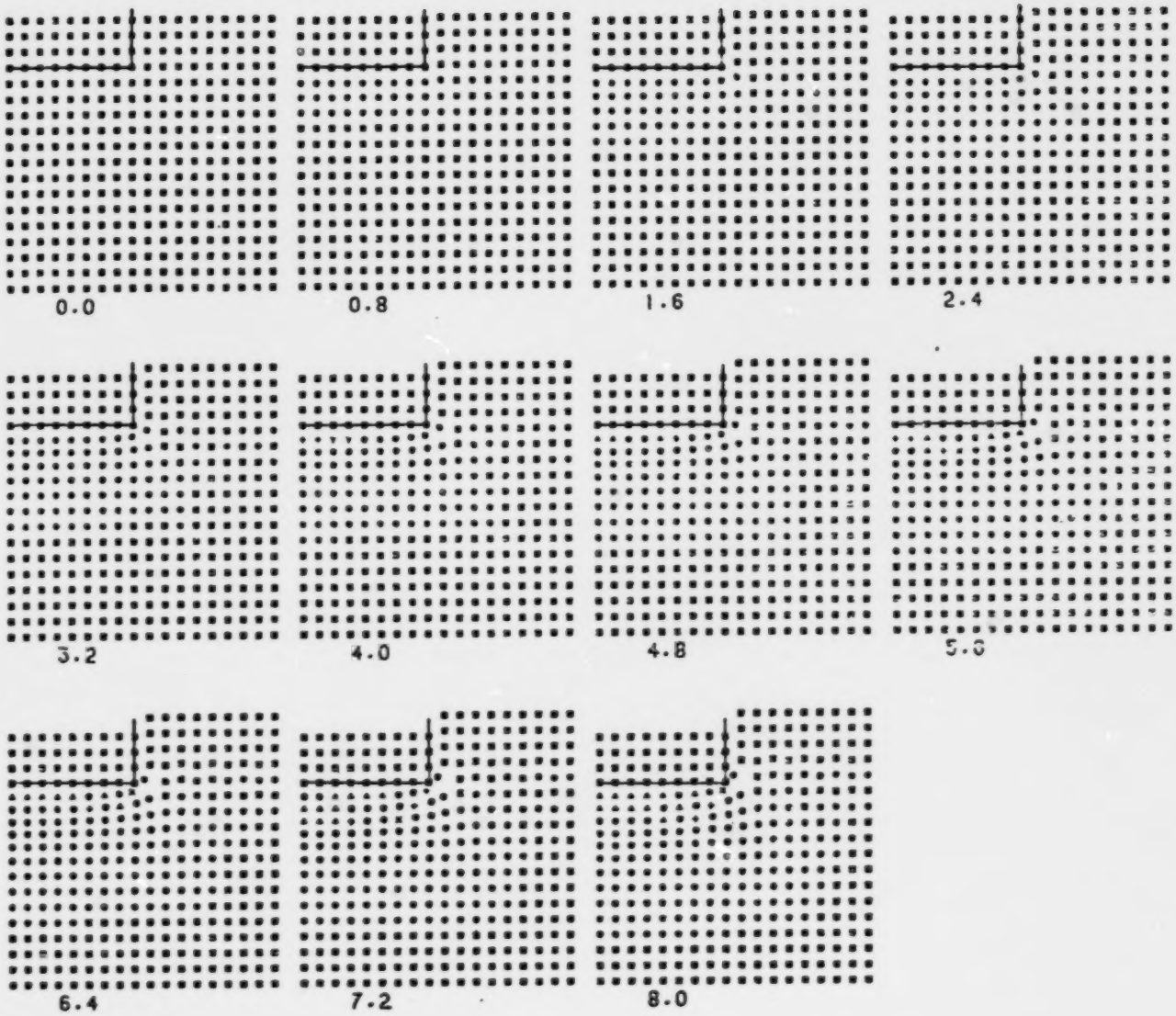

FIGURE 13A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 11)

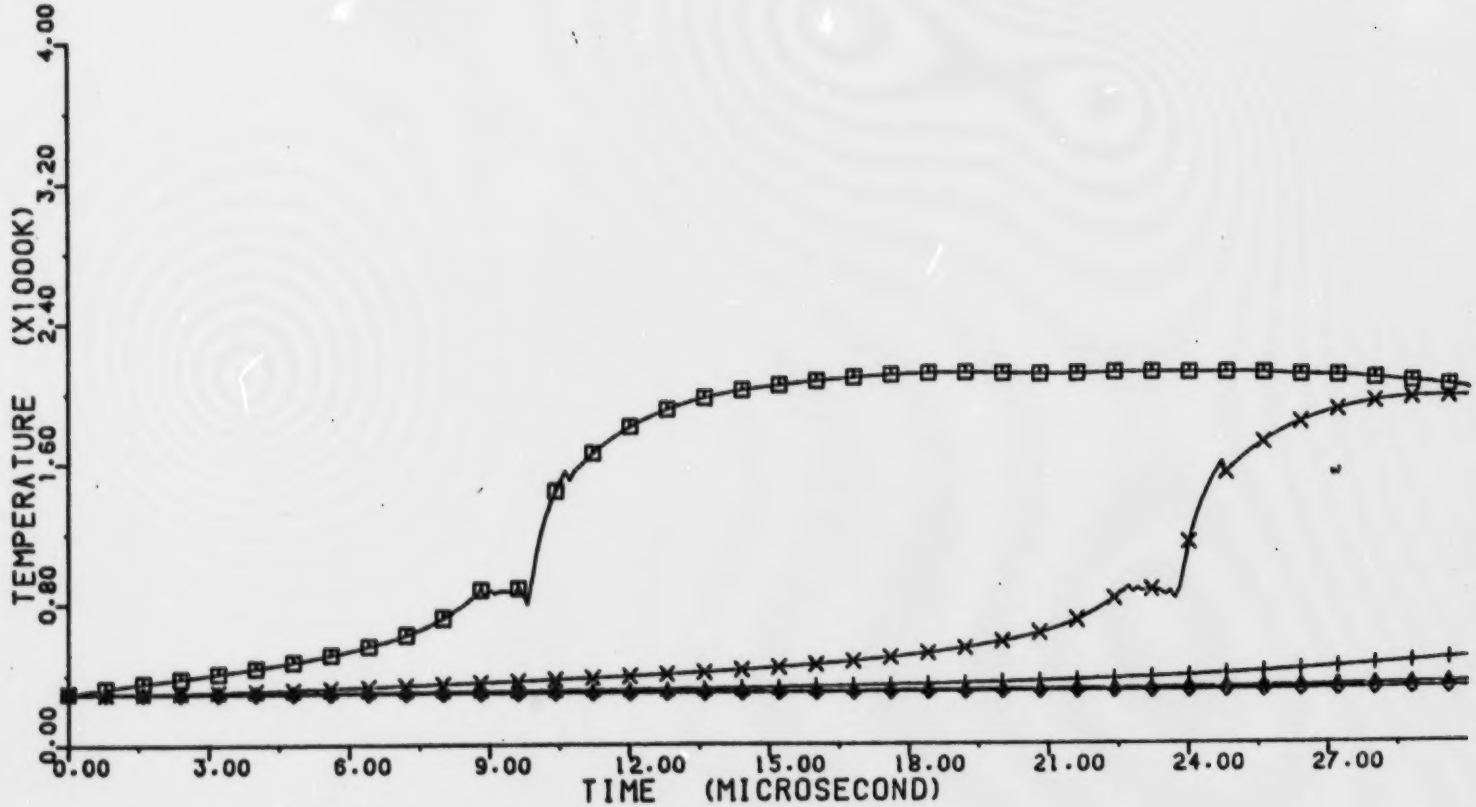

FIGURE 13B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 11)

FIGURE 13C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 11)

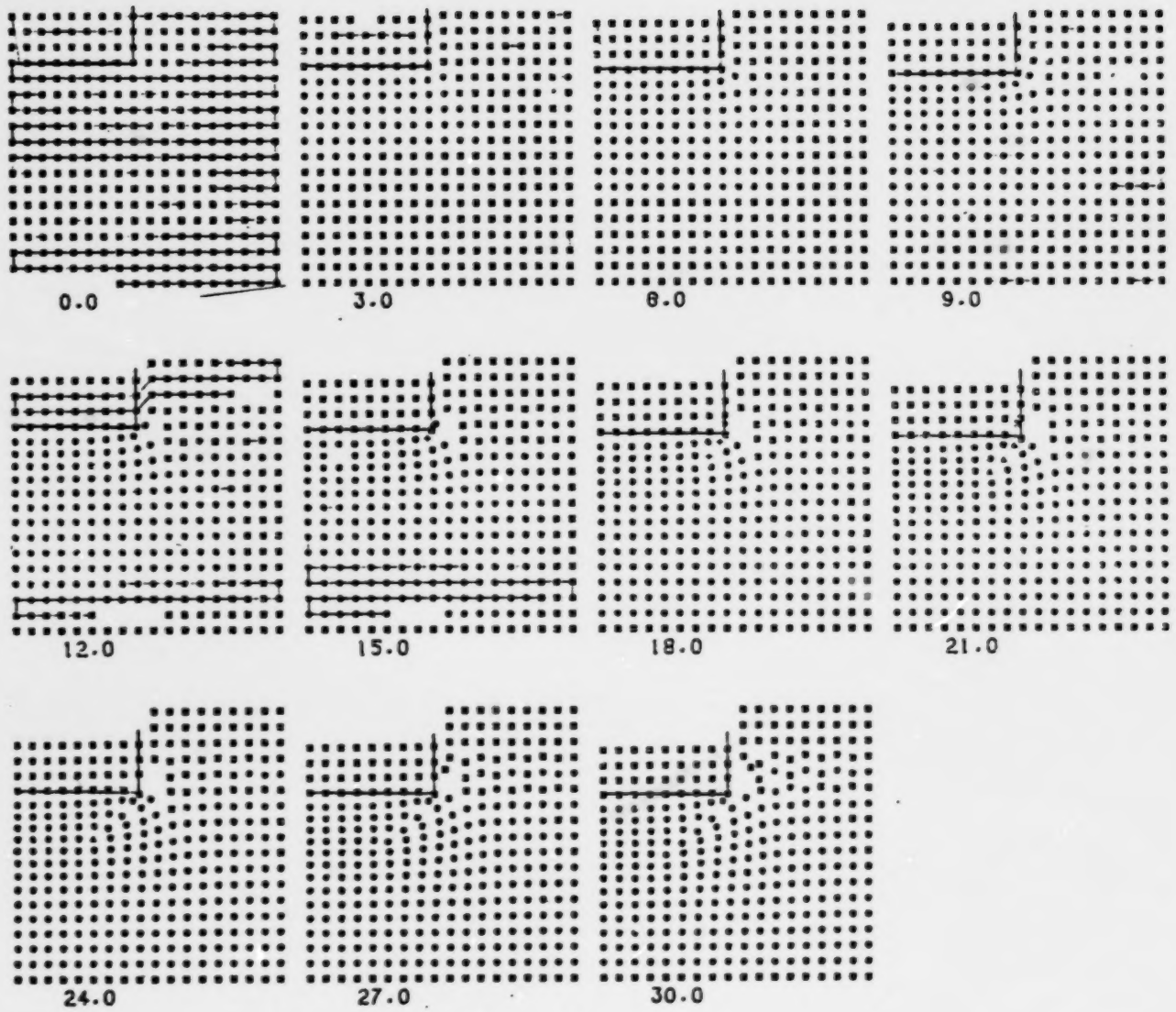

FIGURE 14A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 12)

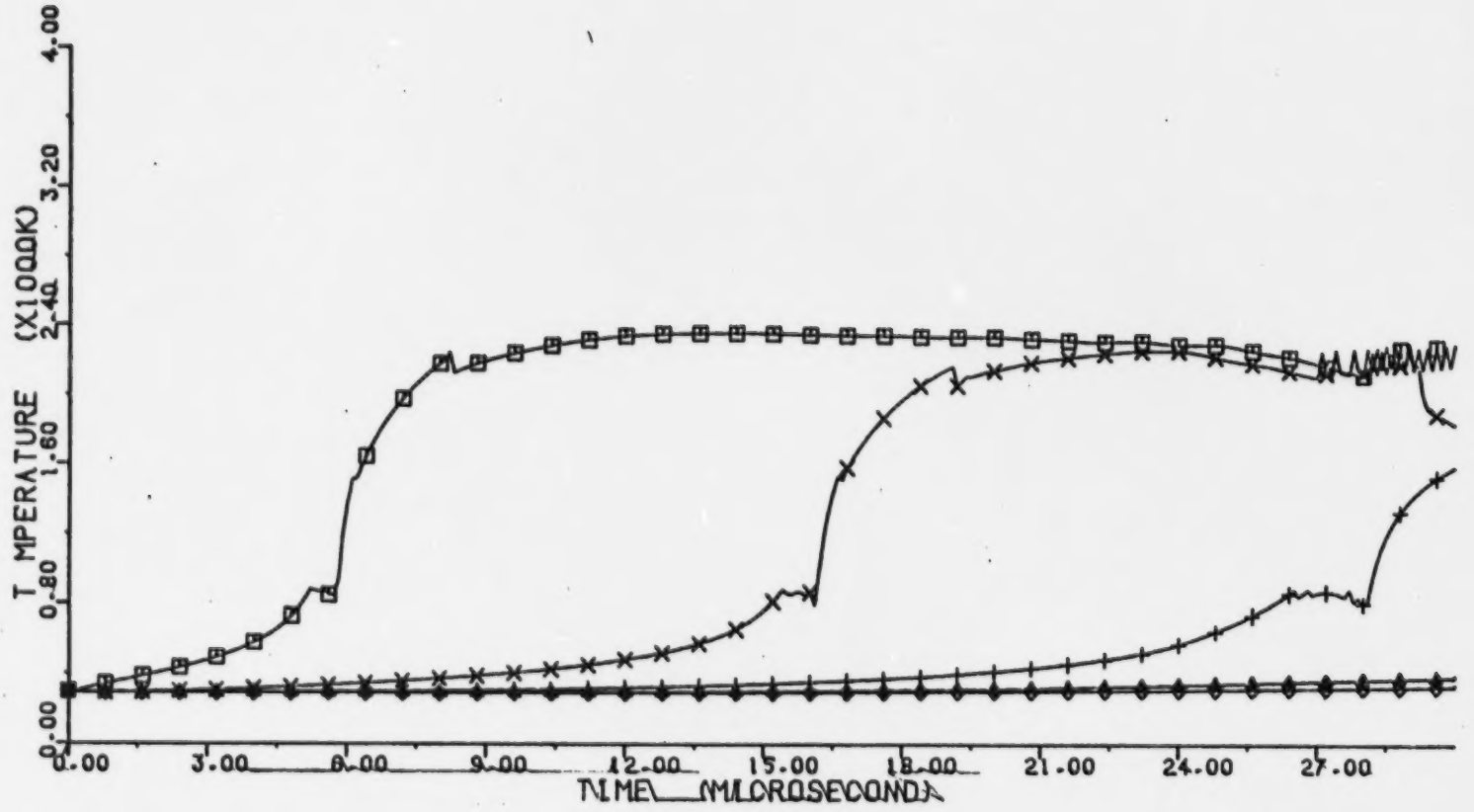

FIGURE 14B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 12)

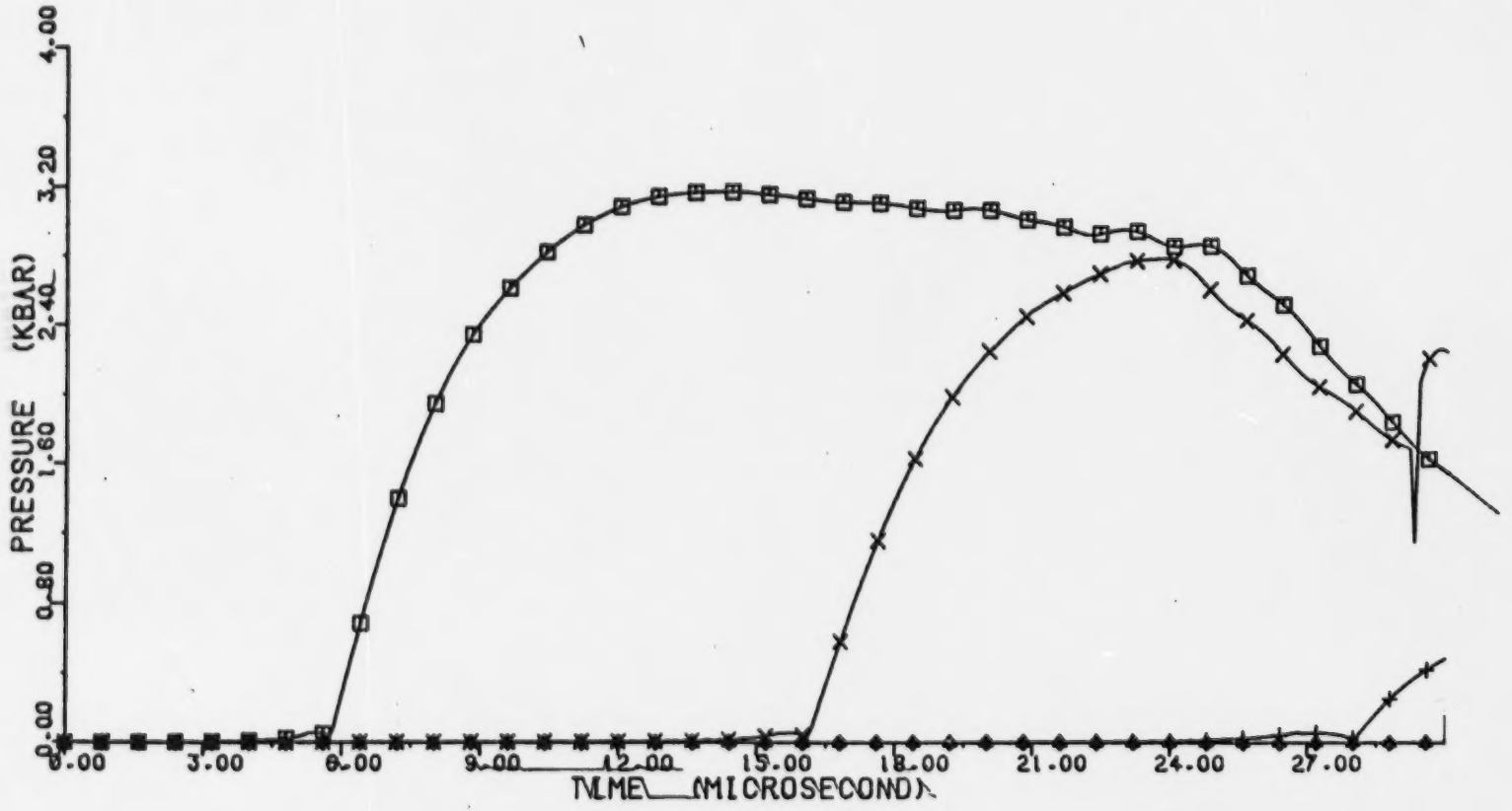

FIGURE 14C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 12)

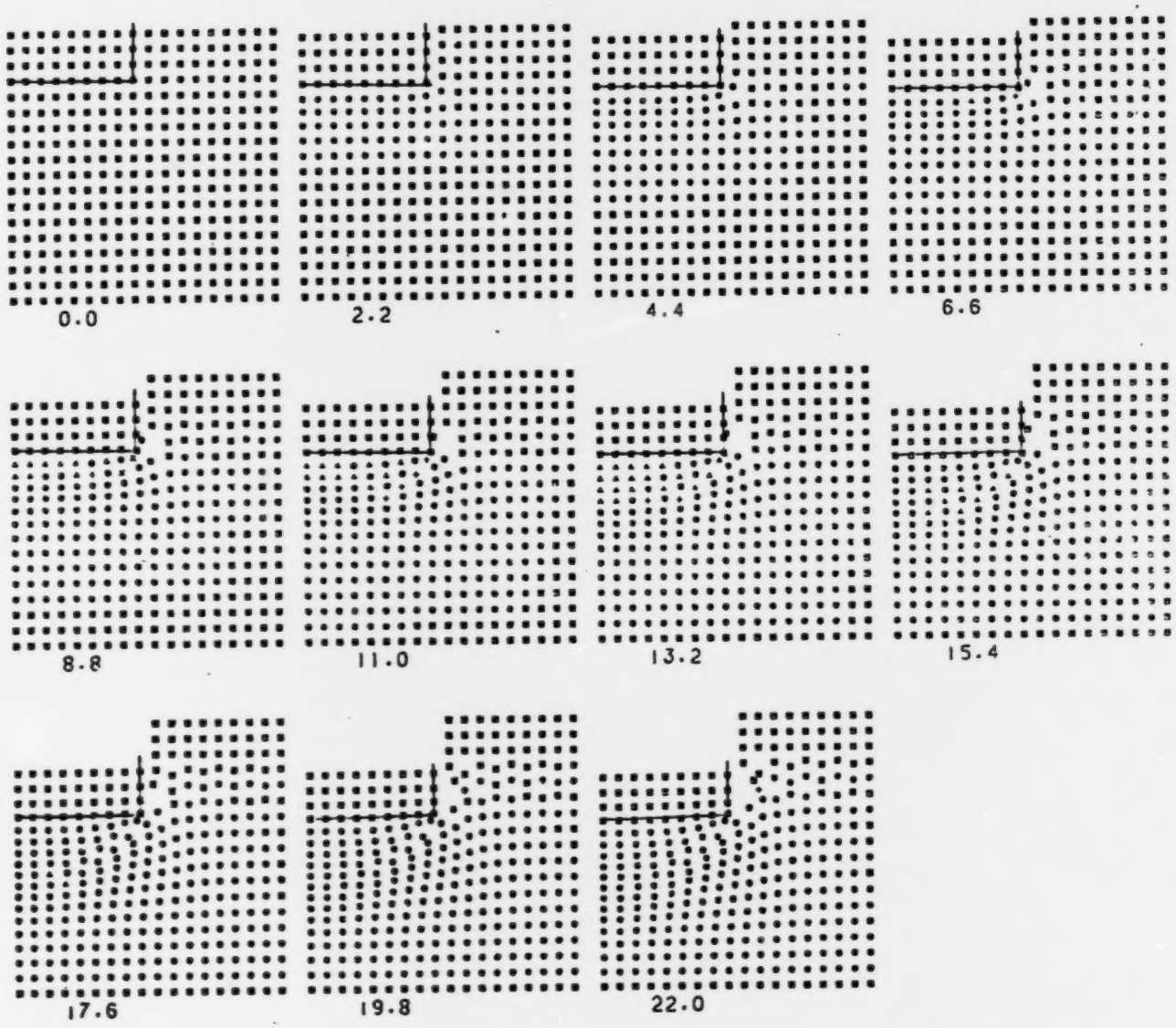

FIGURE 15A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 13)

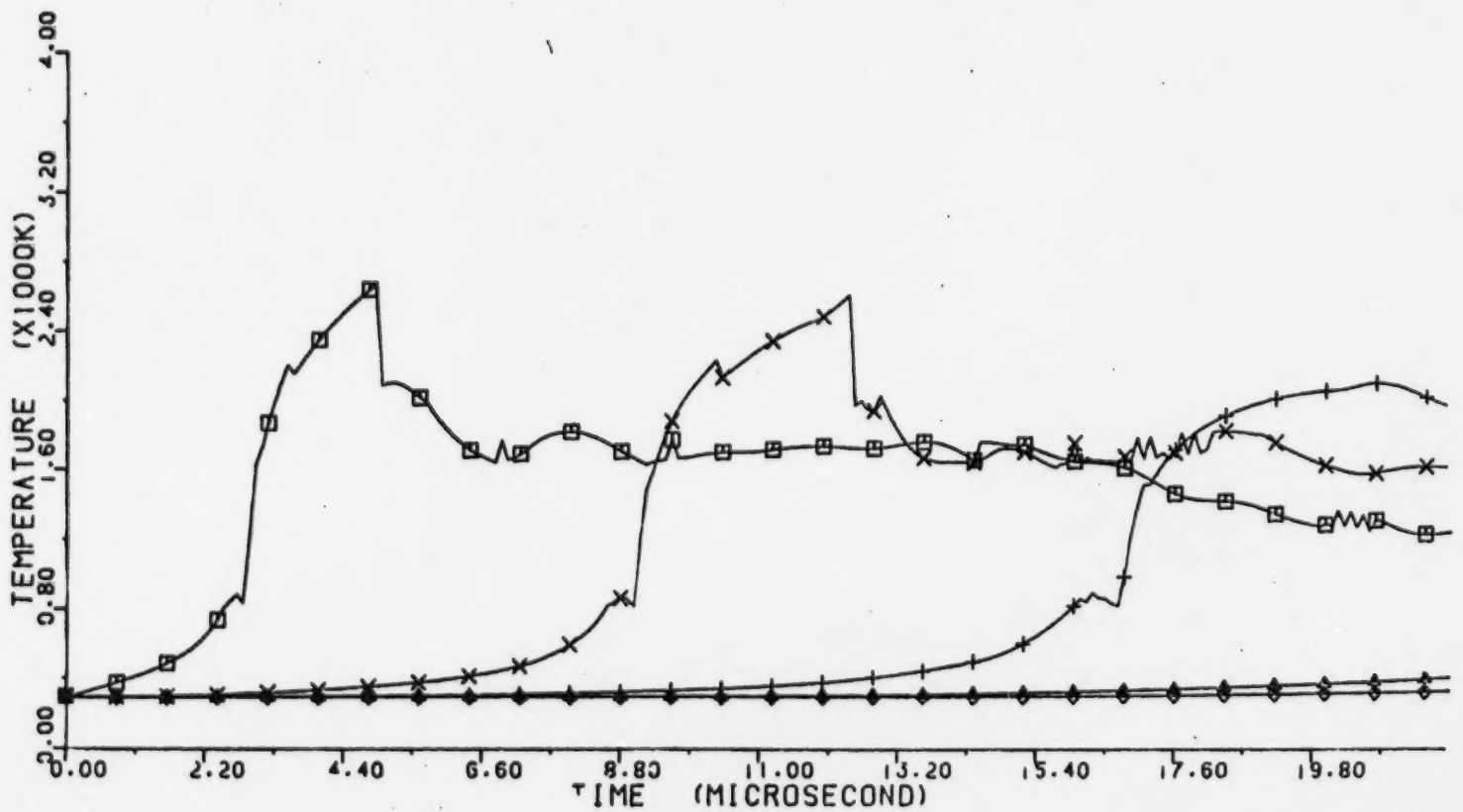

FIGURE 15B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 13)

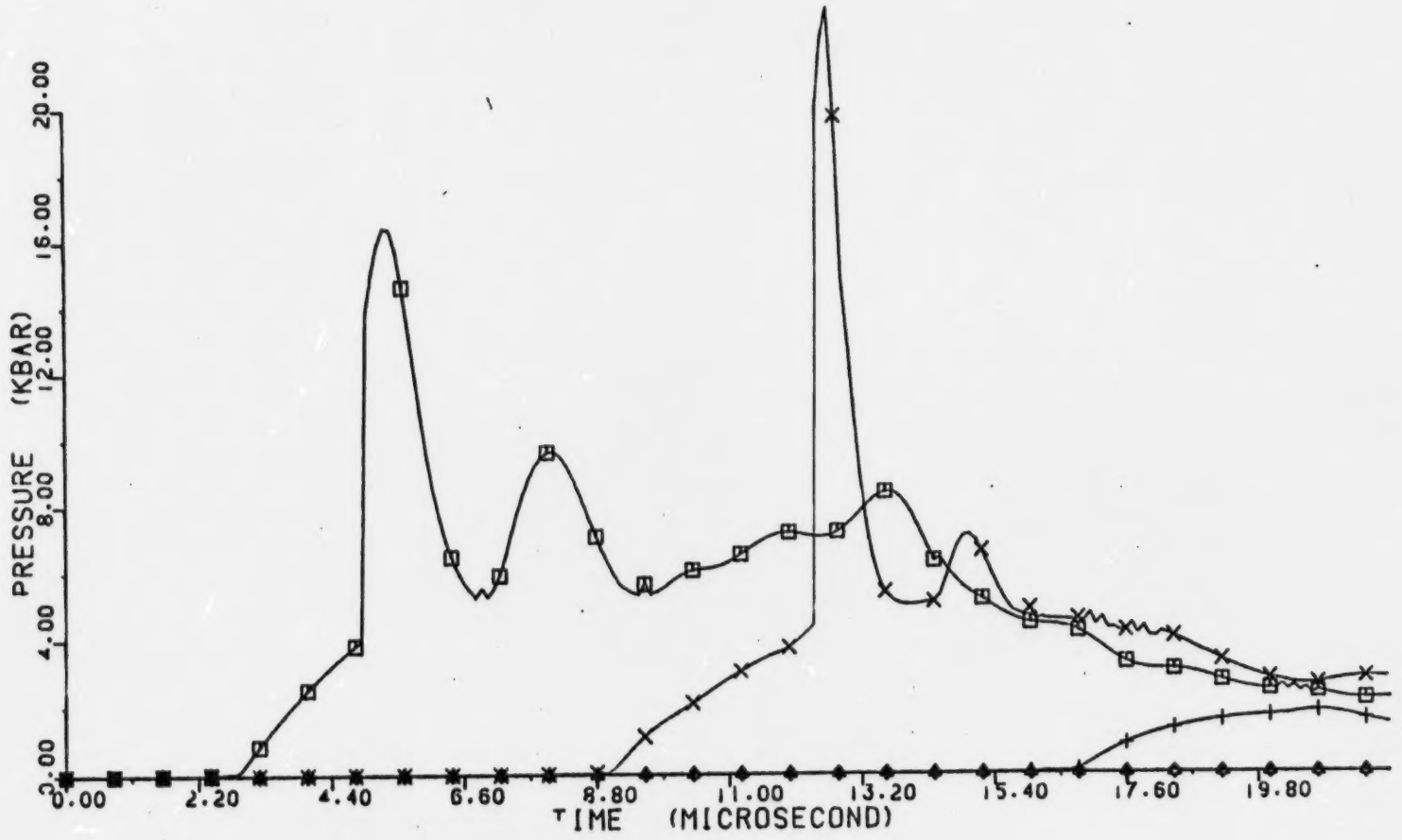

FIGURE 15C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 13)

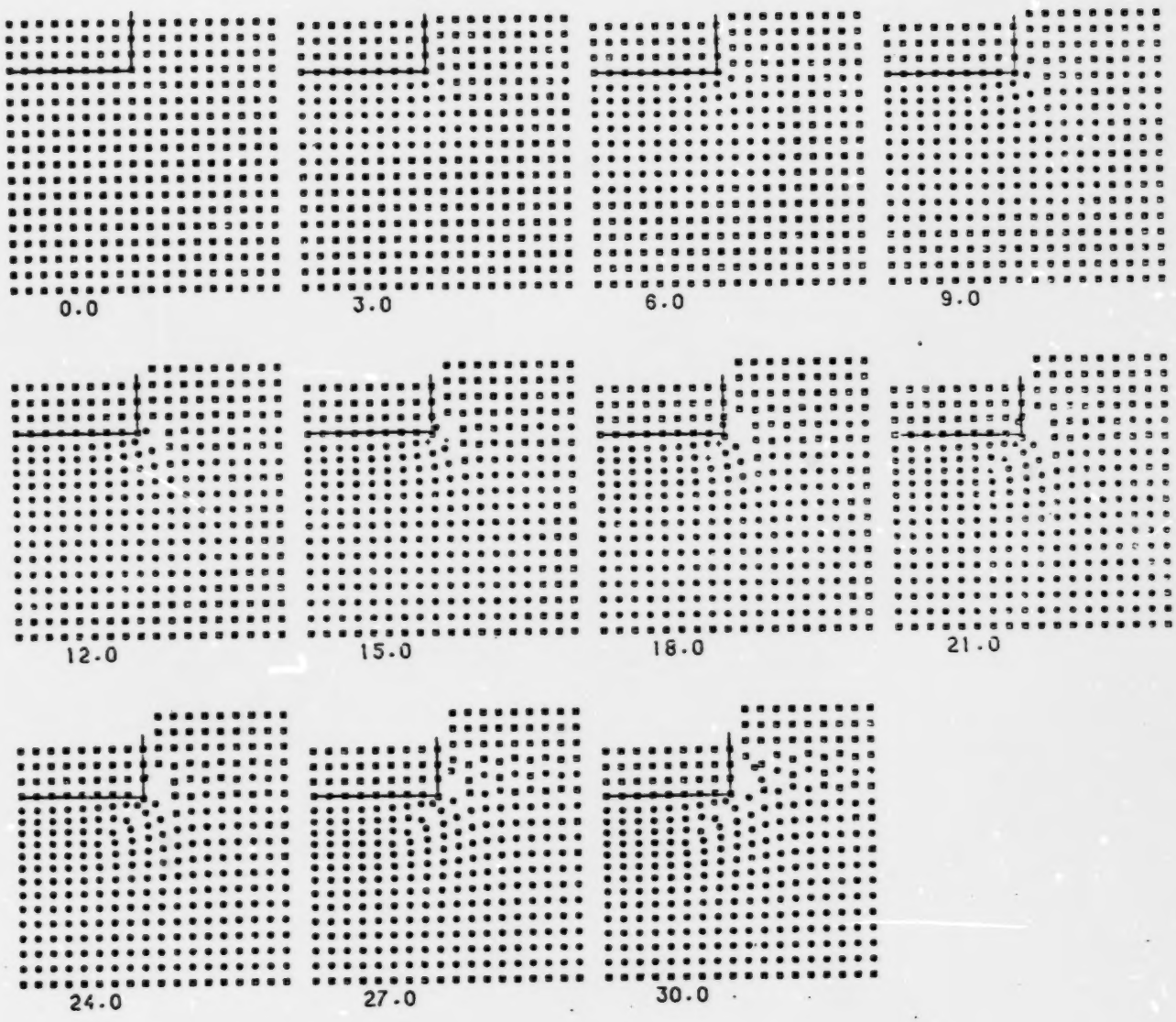

FIGURE 16A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 14)

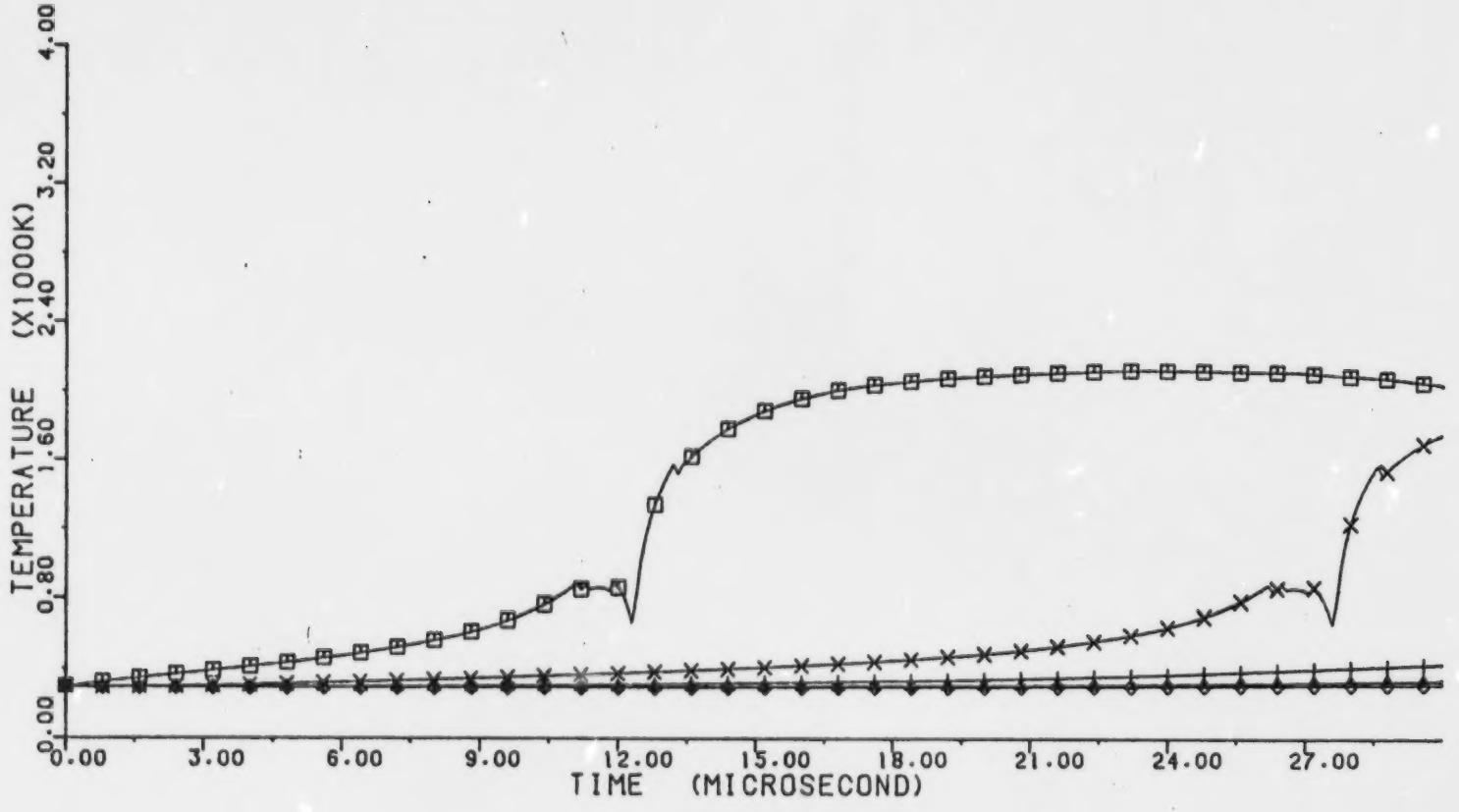

FIGURE 16B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 14)

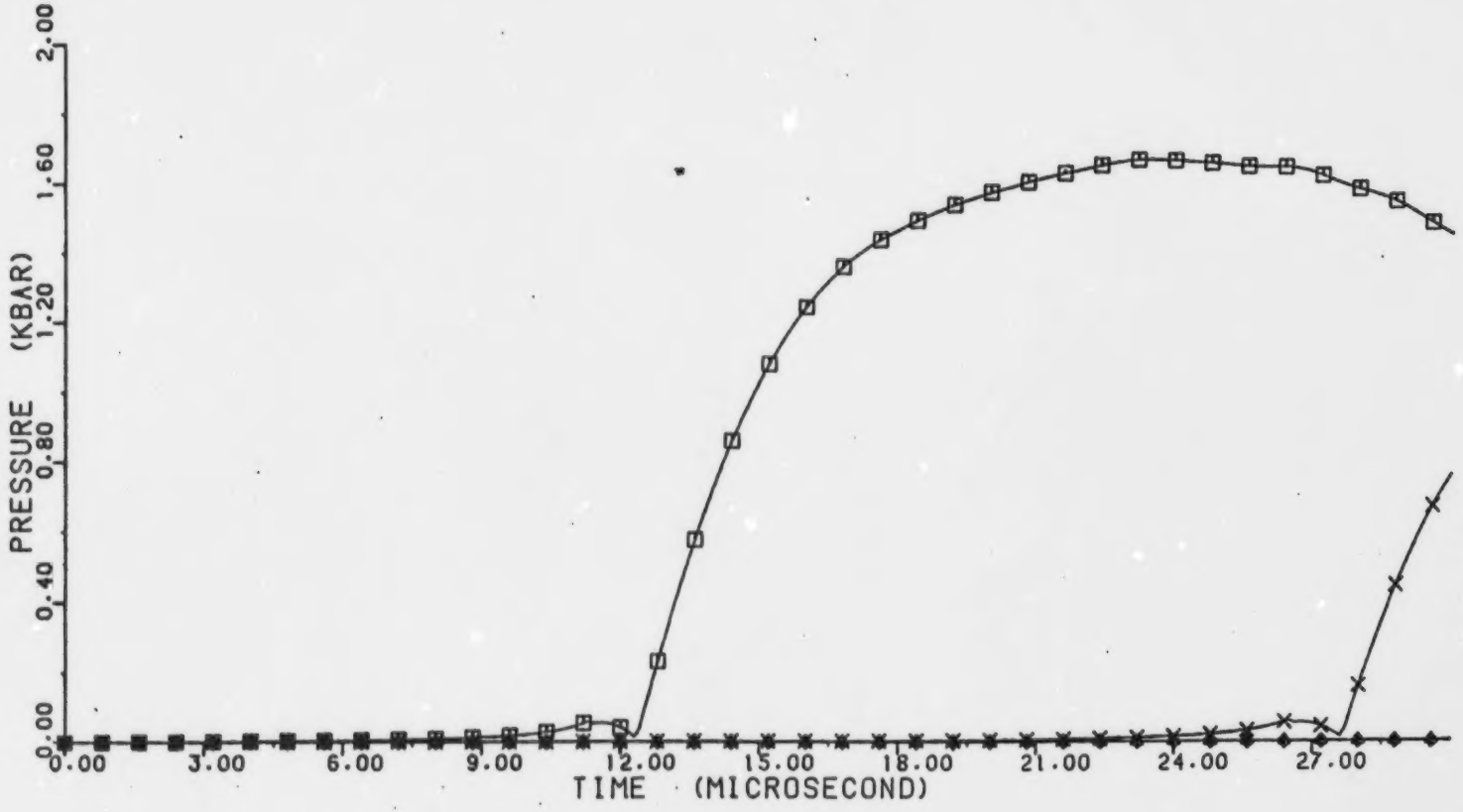

FIGURE 16C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 14)

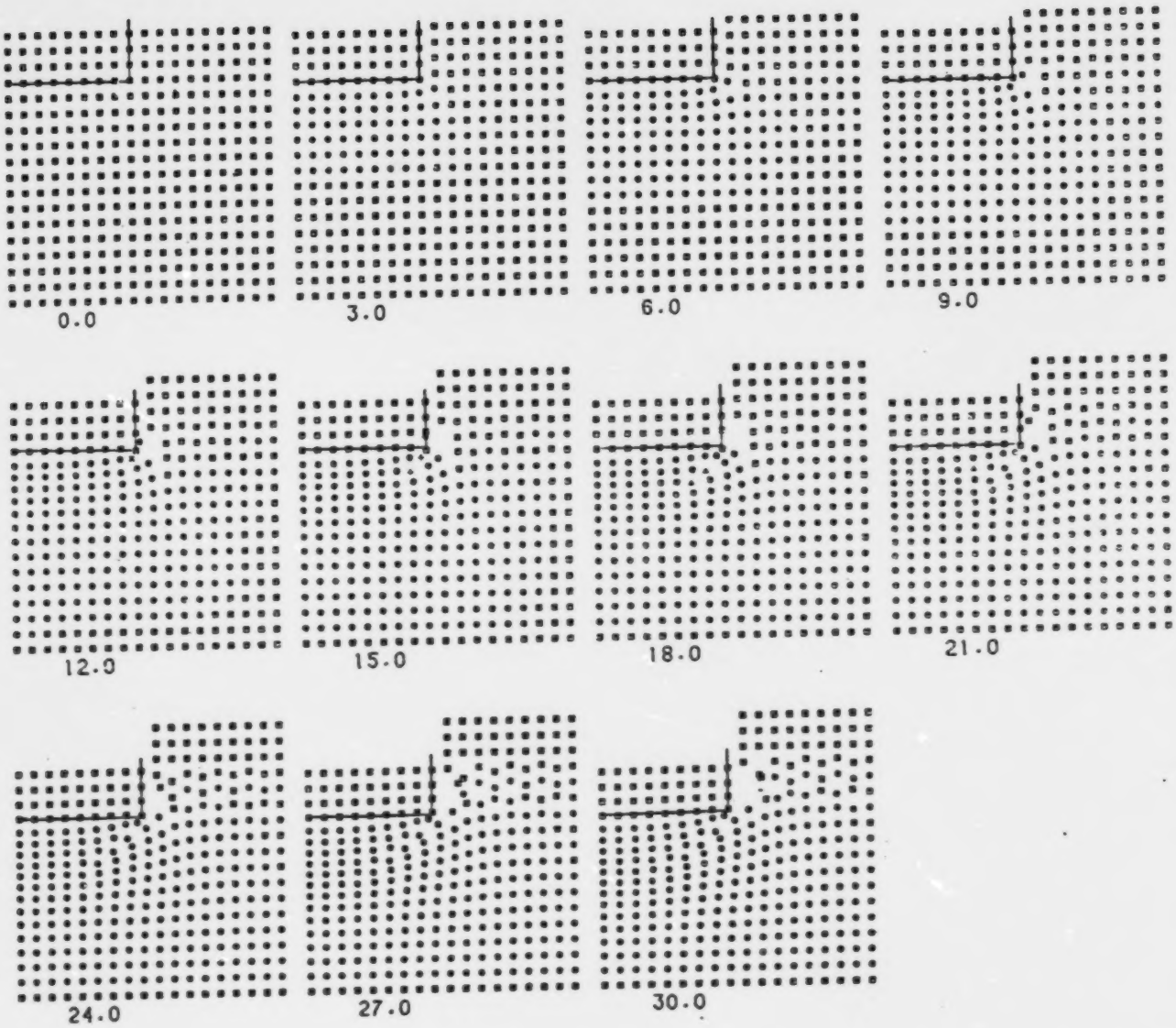

FIGURE 17A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 15)

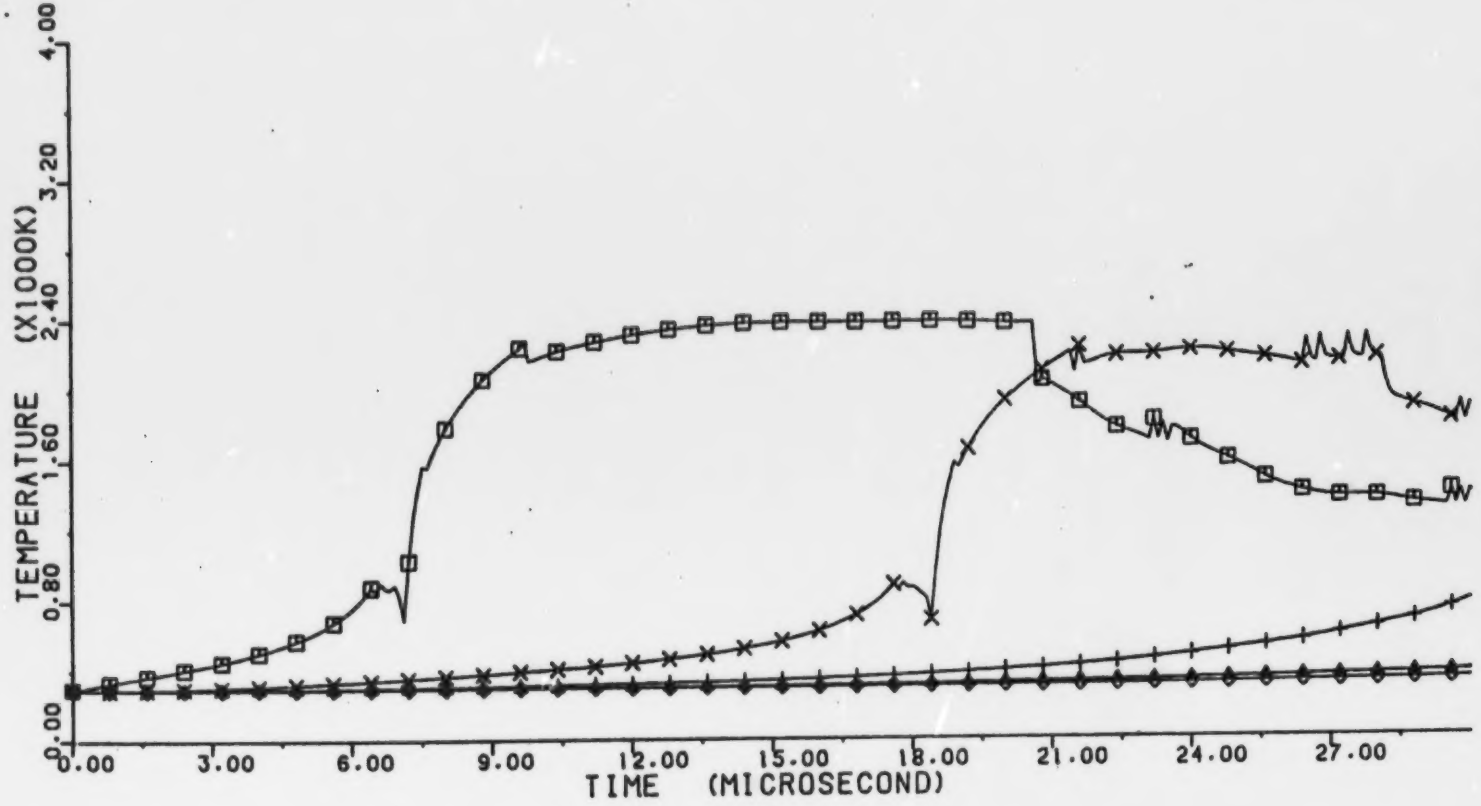

FIGURE 17B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 15)

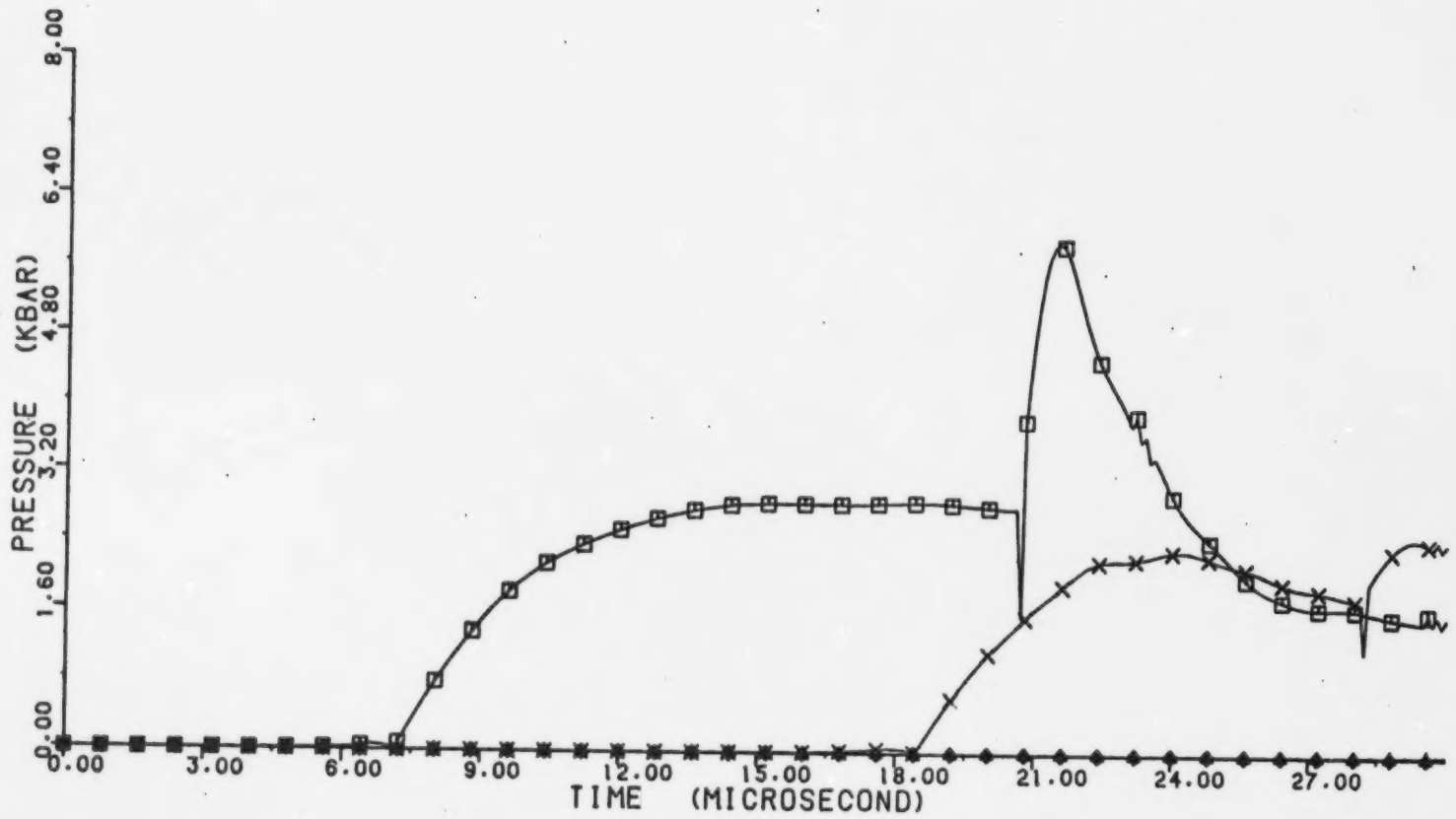

FIGURE 17C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 15)

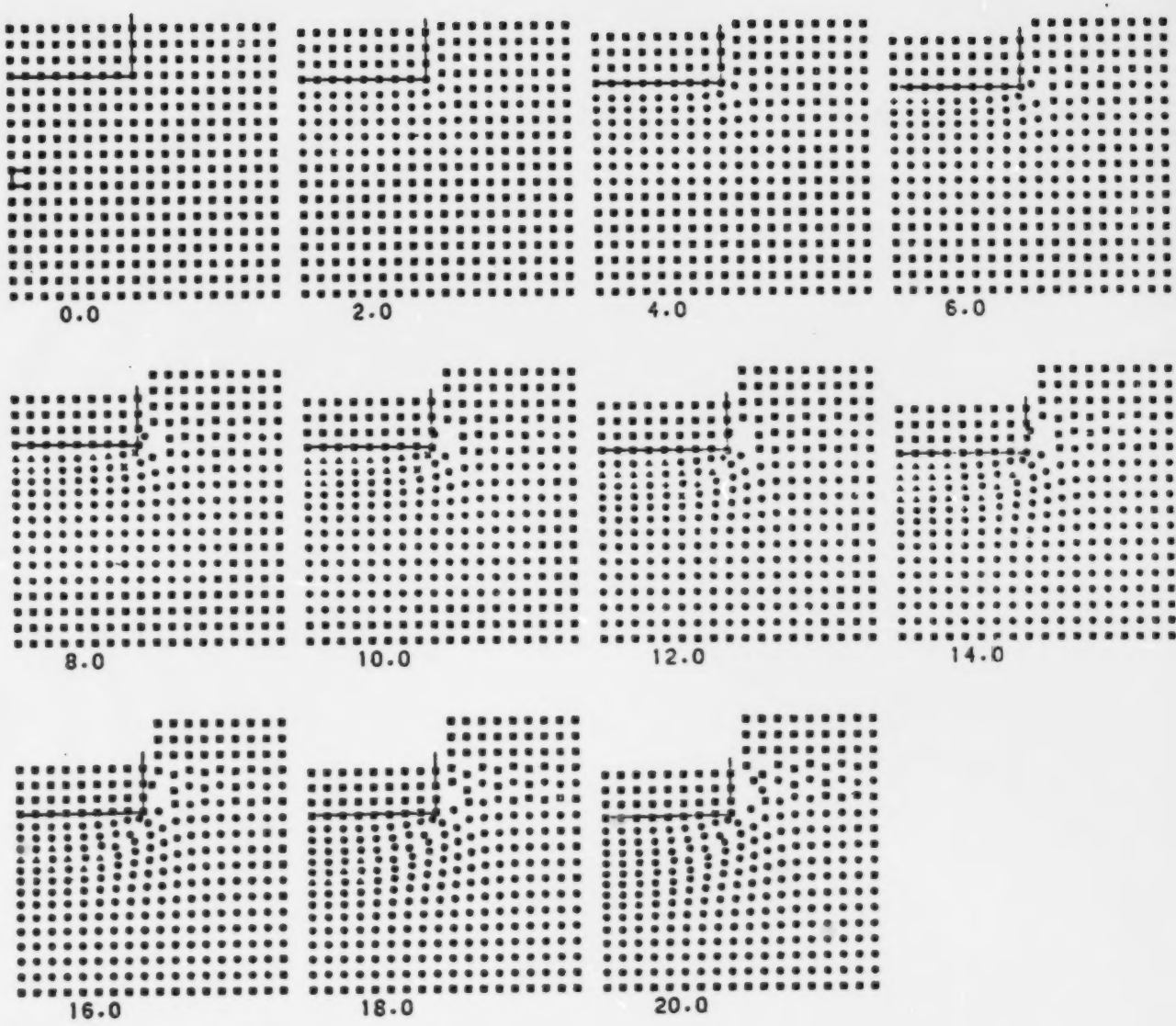

FIGURE 18A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 16)

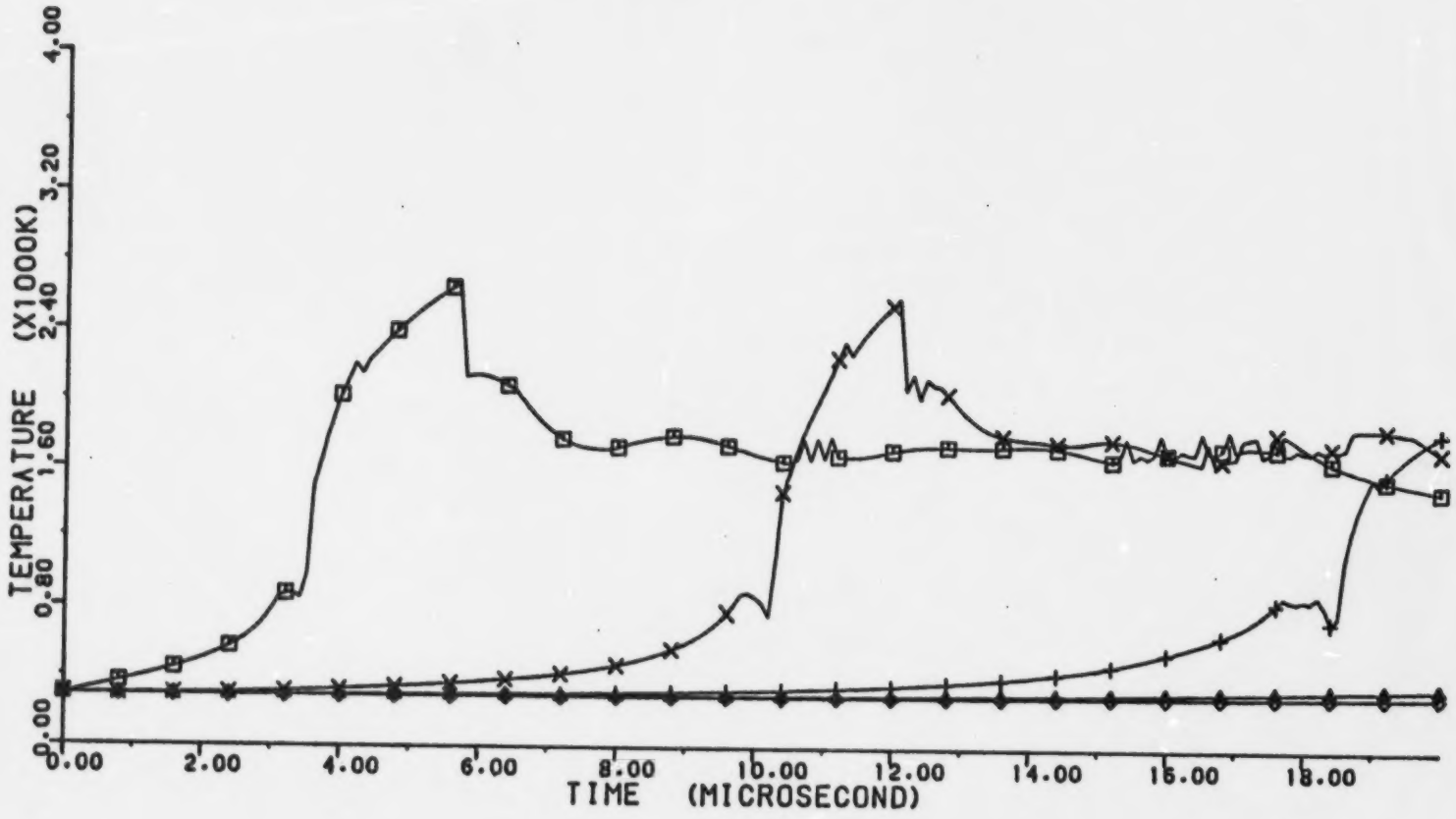

FIGURE 18B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 16)

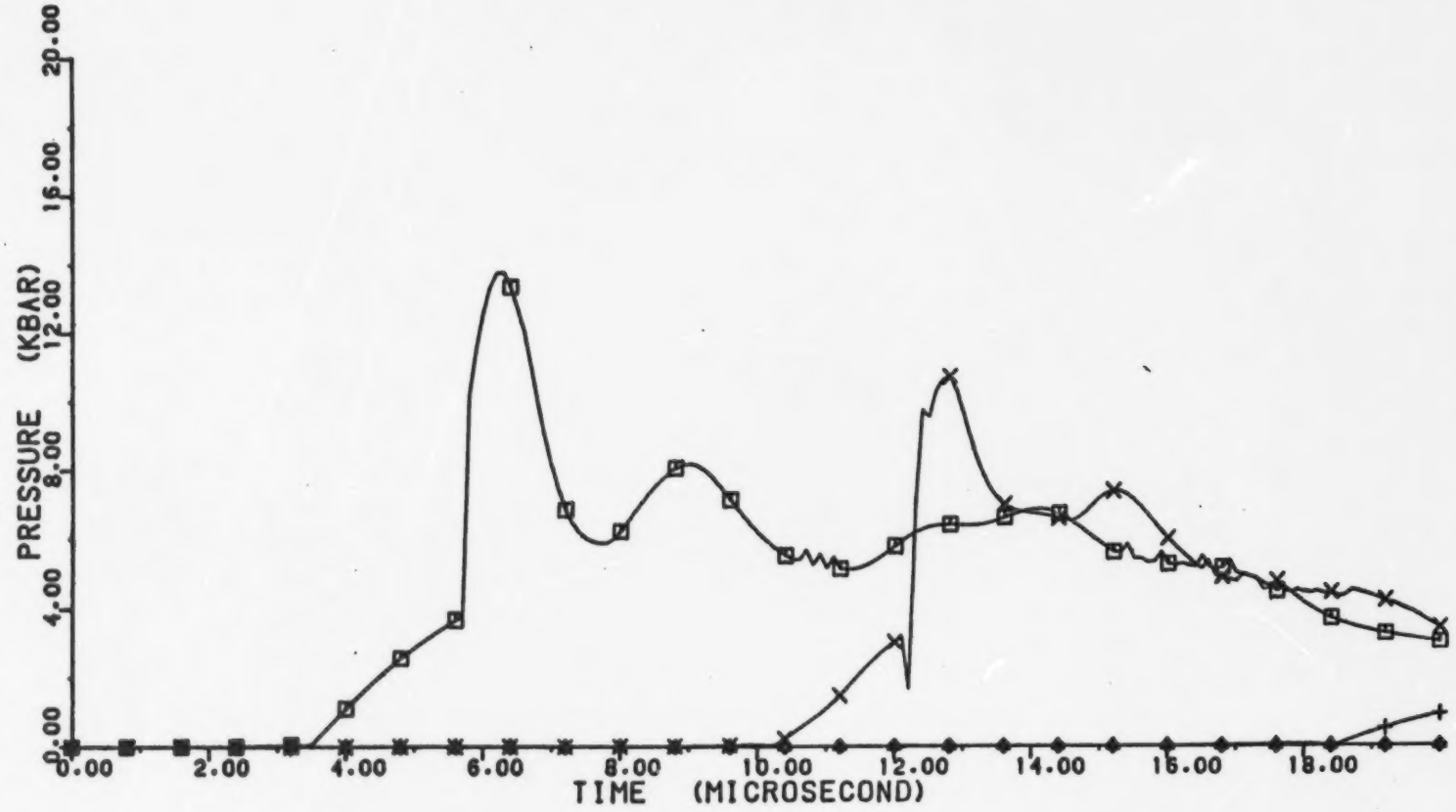

FIGURE 18C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 16)

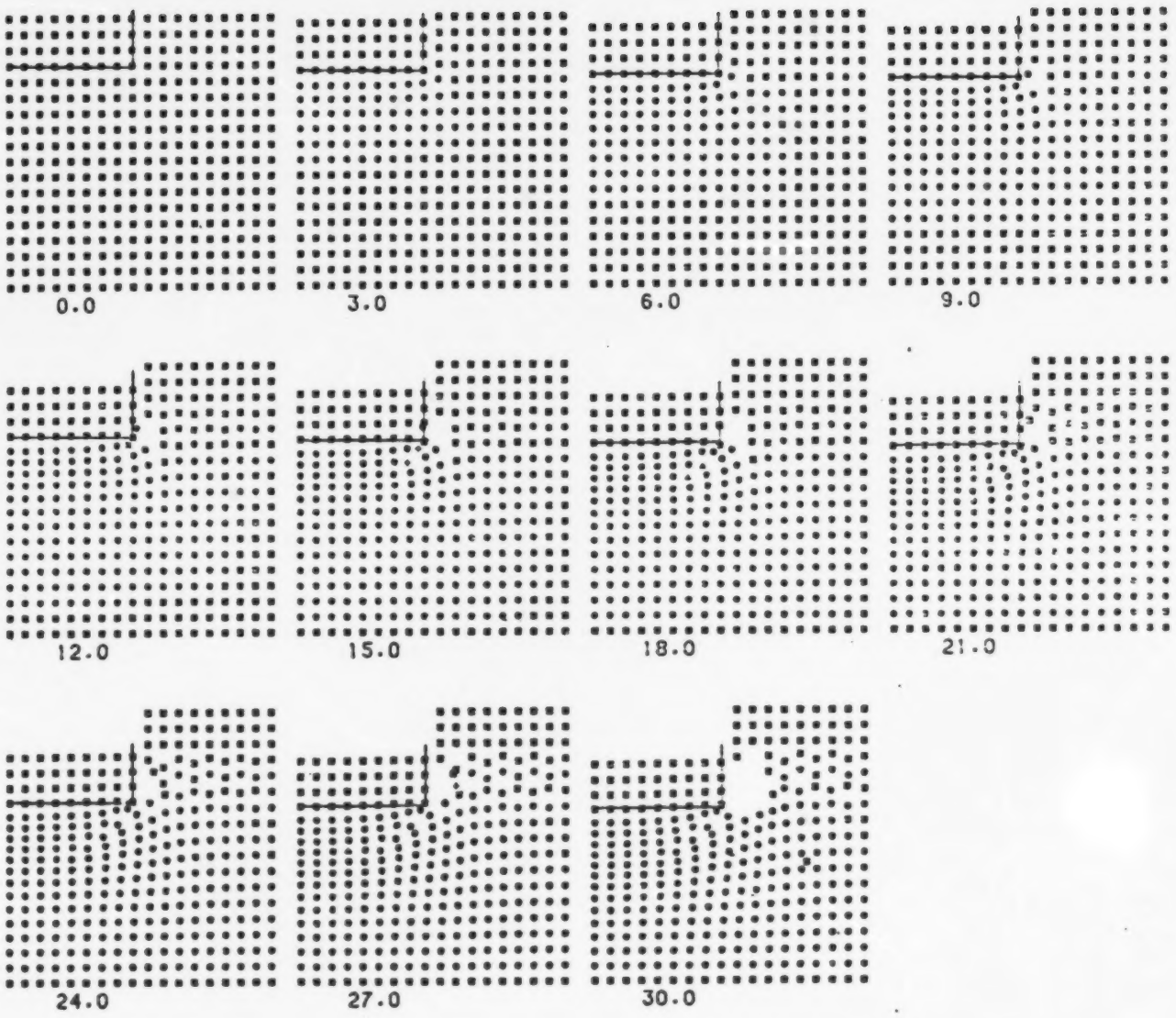

FIGURE 19A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 17)

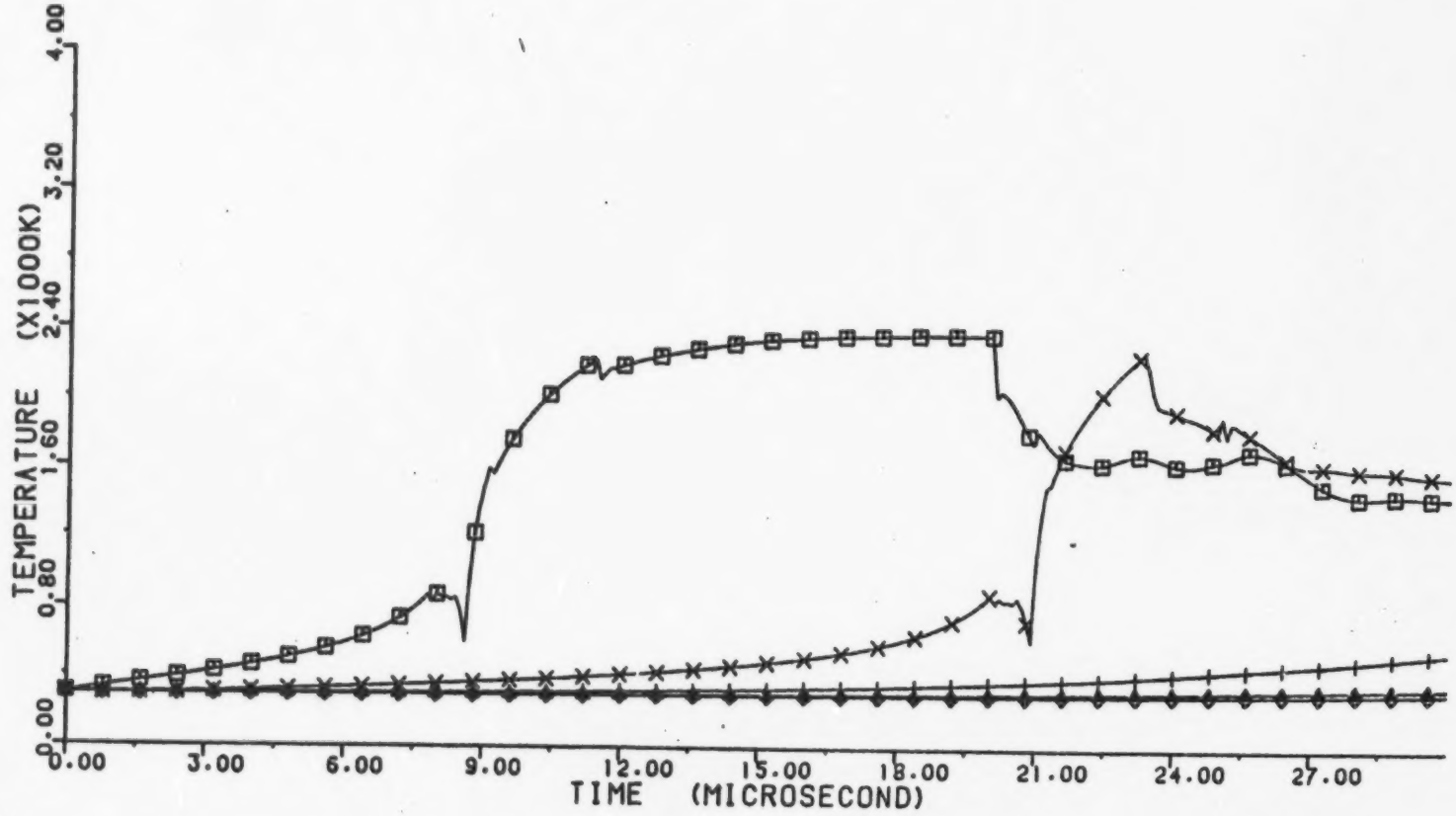

FIGURE 19B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 17)

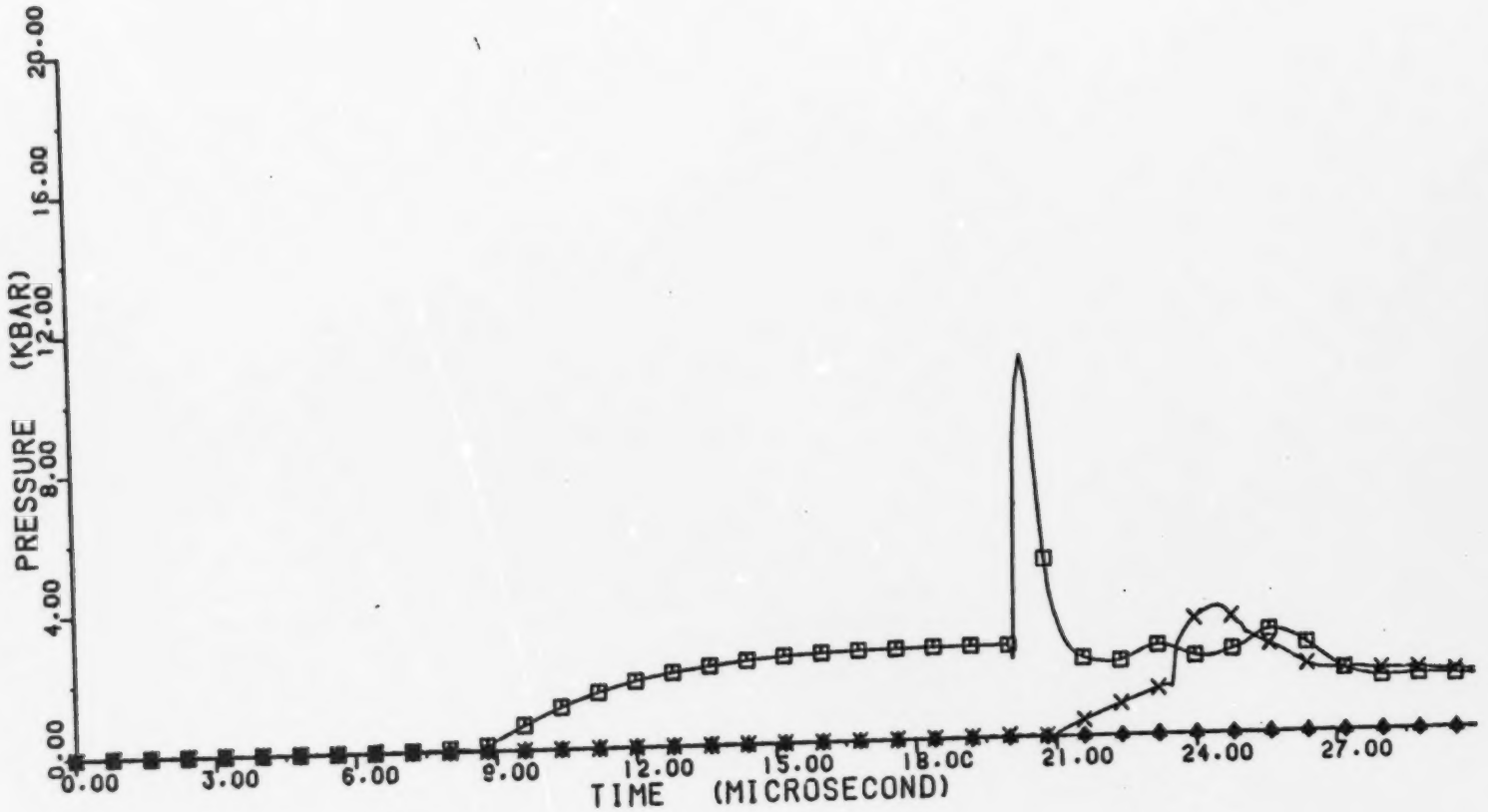

FIGURE 19C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 17)

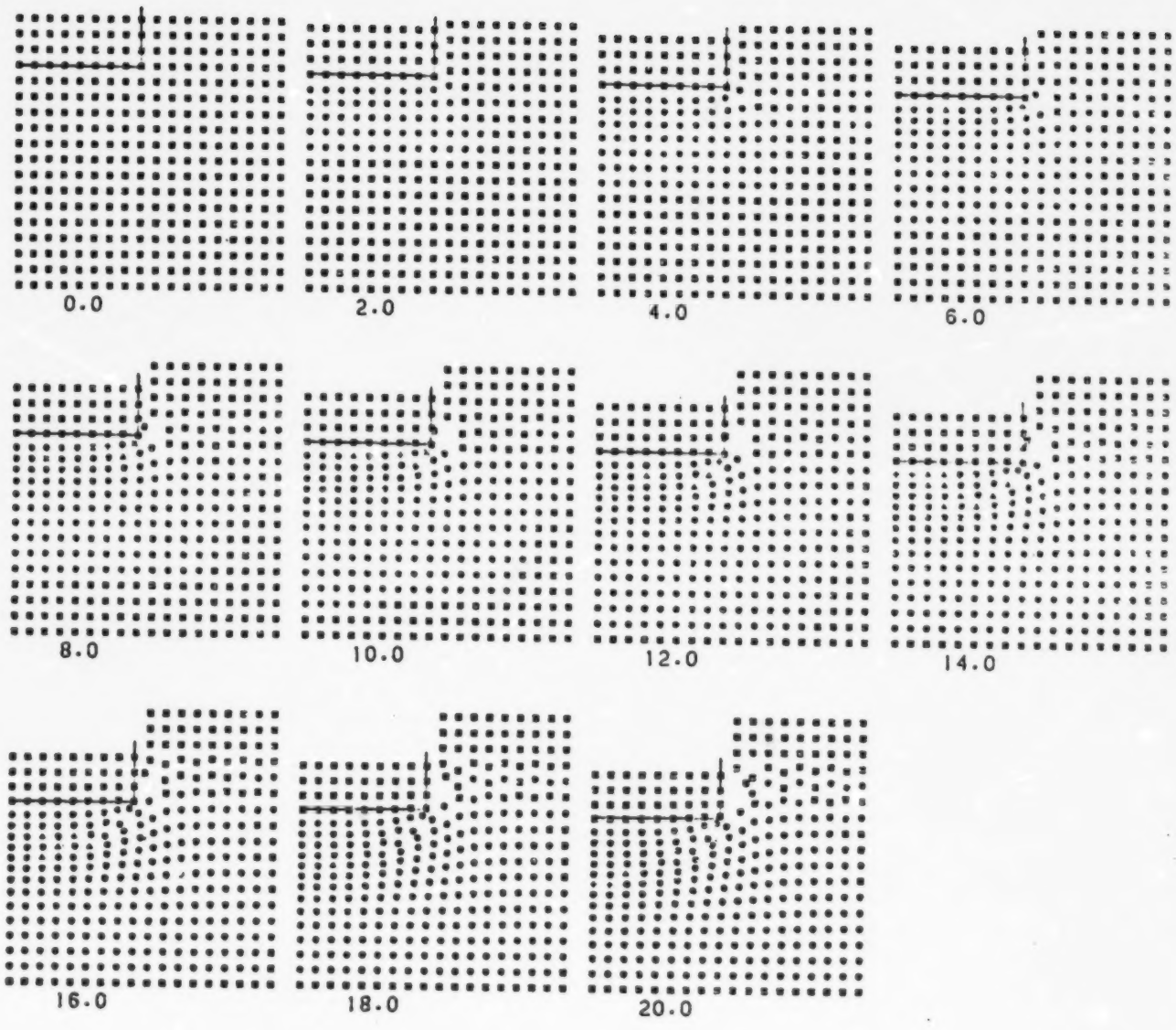

FIGURE 20A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 18)

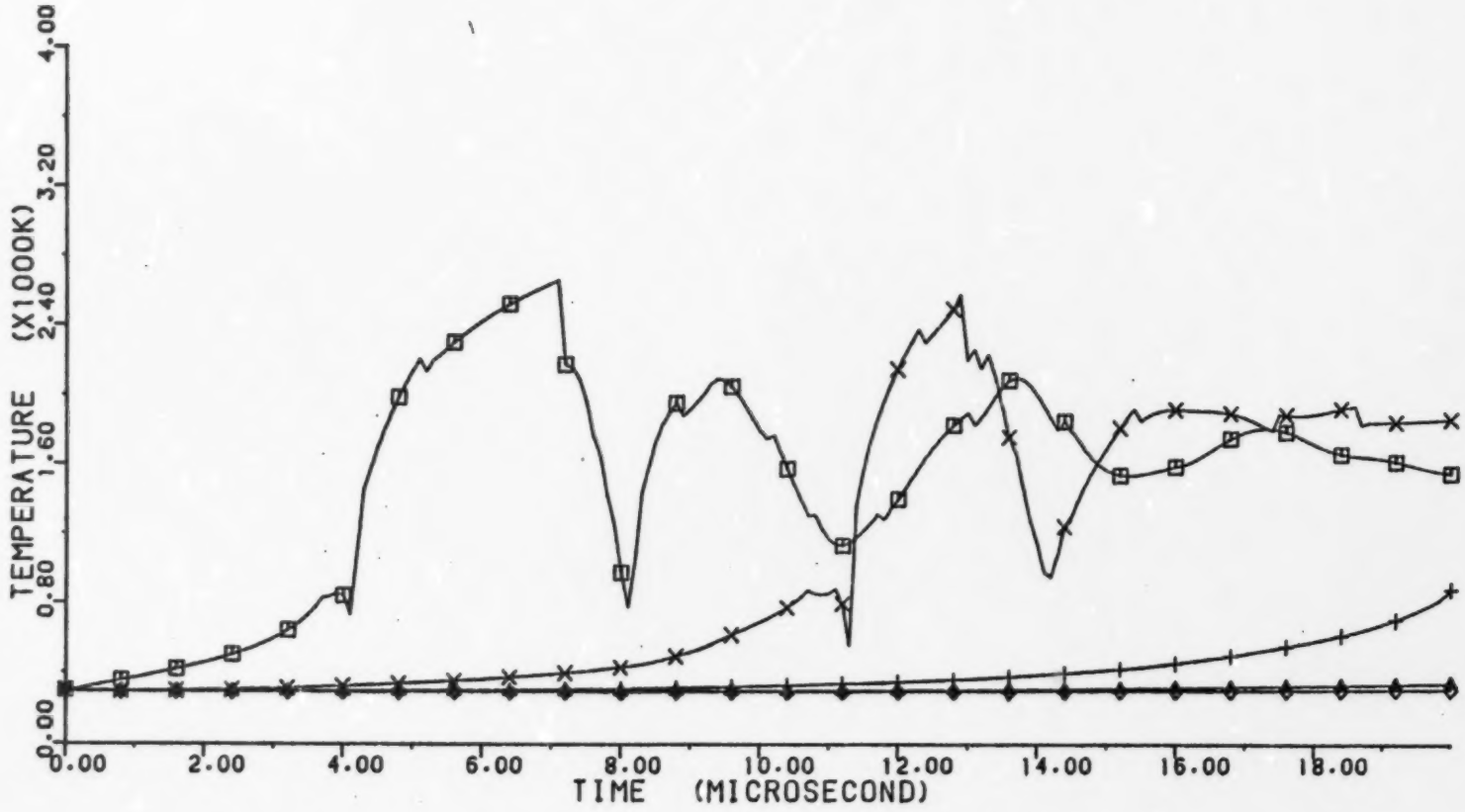

FIGURE 20B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 18)

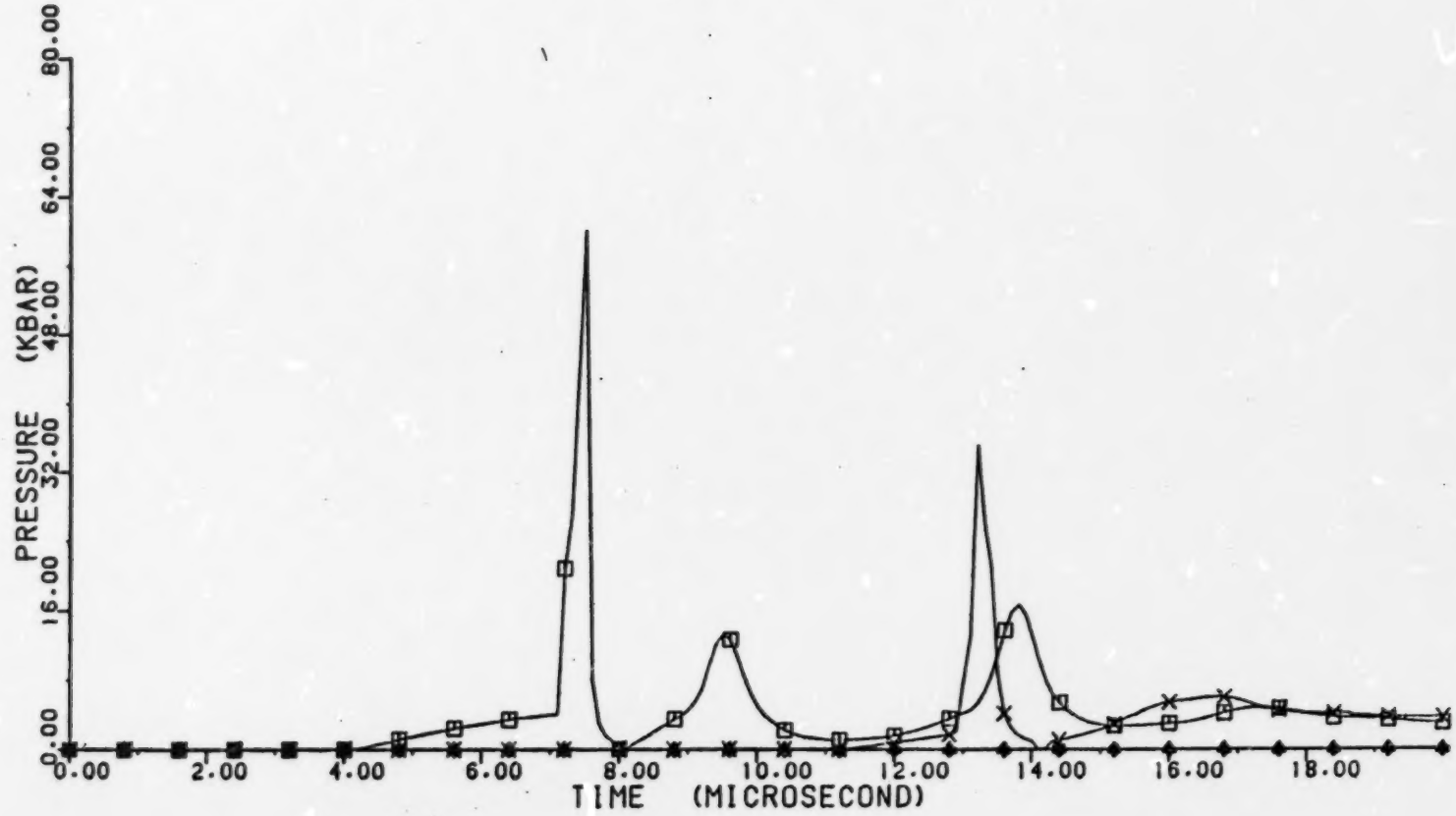

FIGURE 20C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 18)

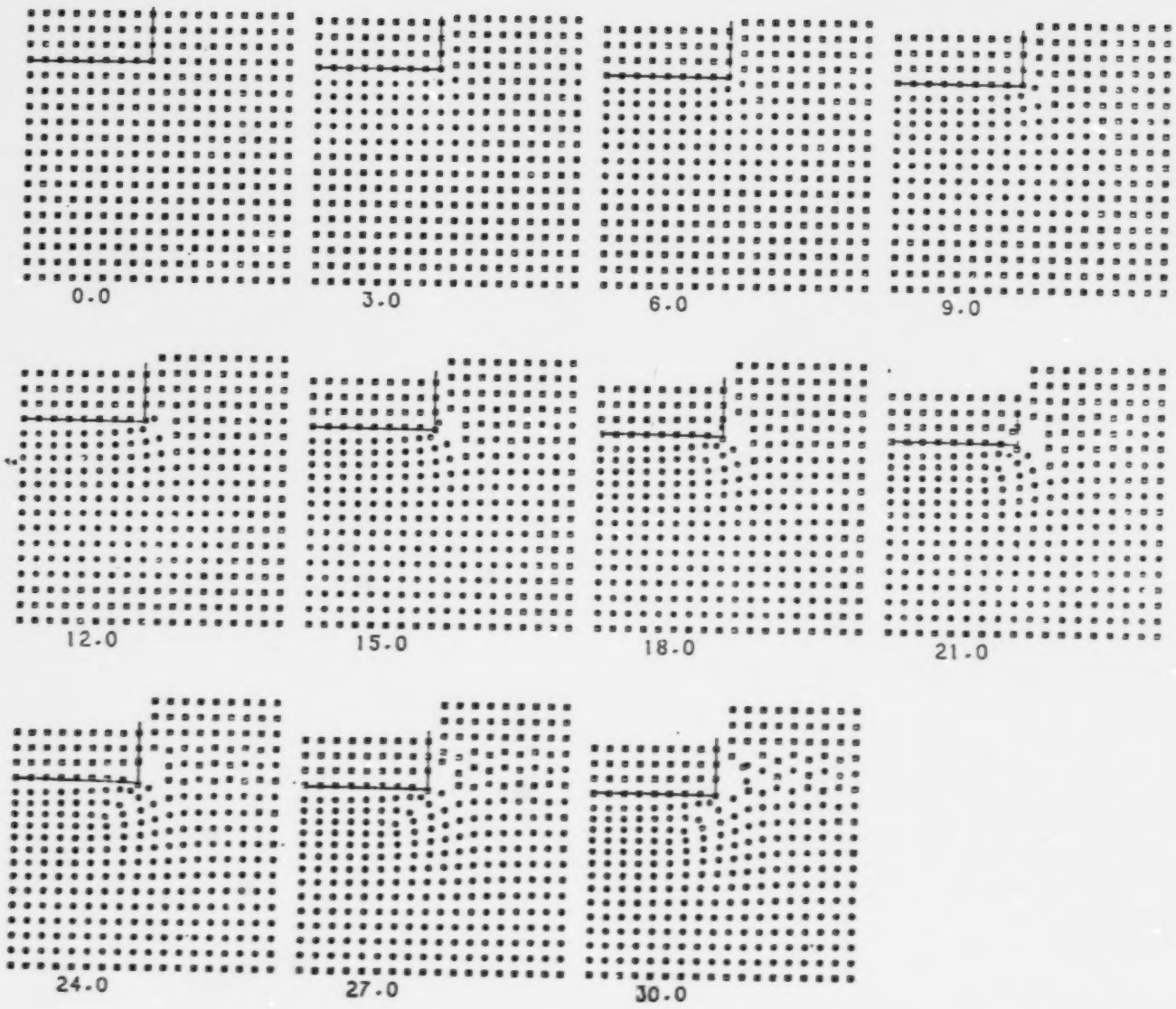

FIGURE 21A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 19)

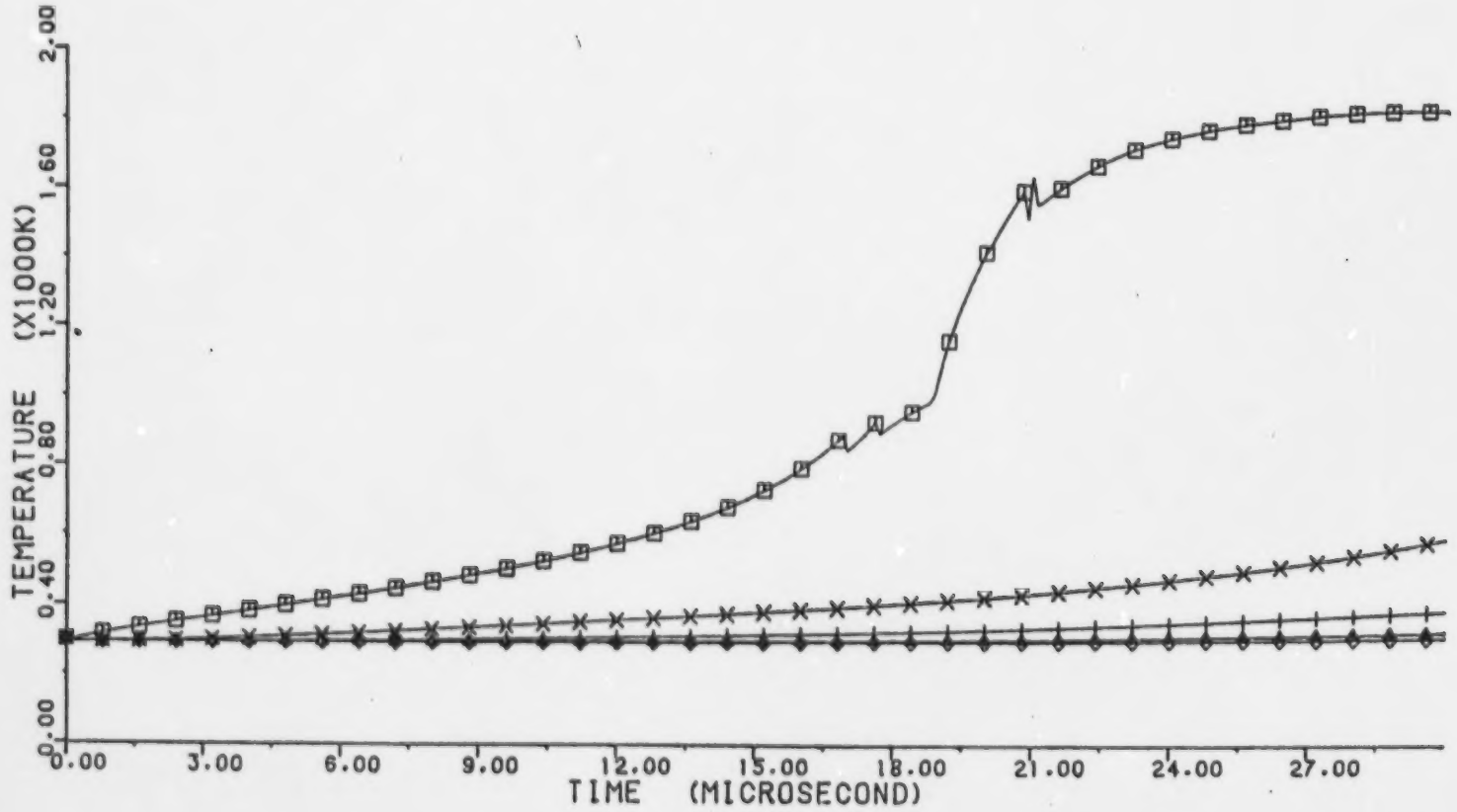

FIGURE 21B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 19)

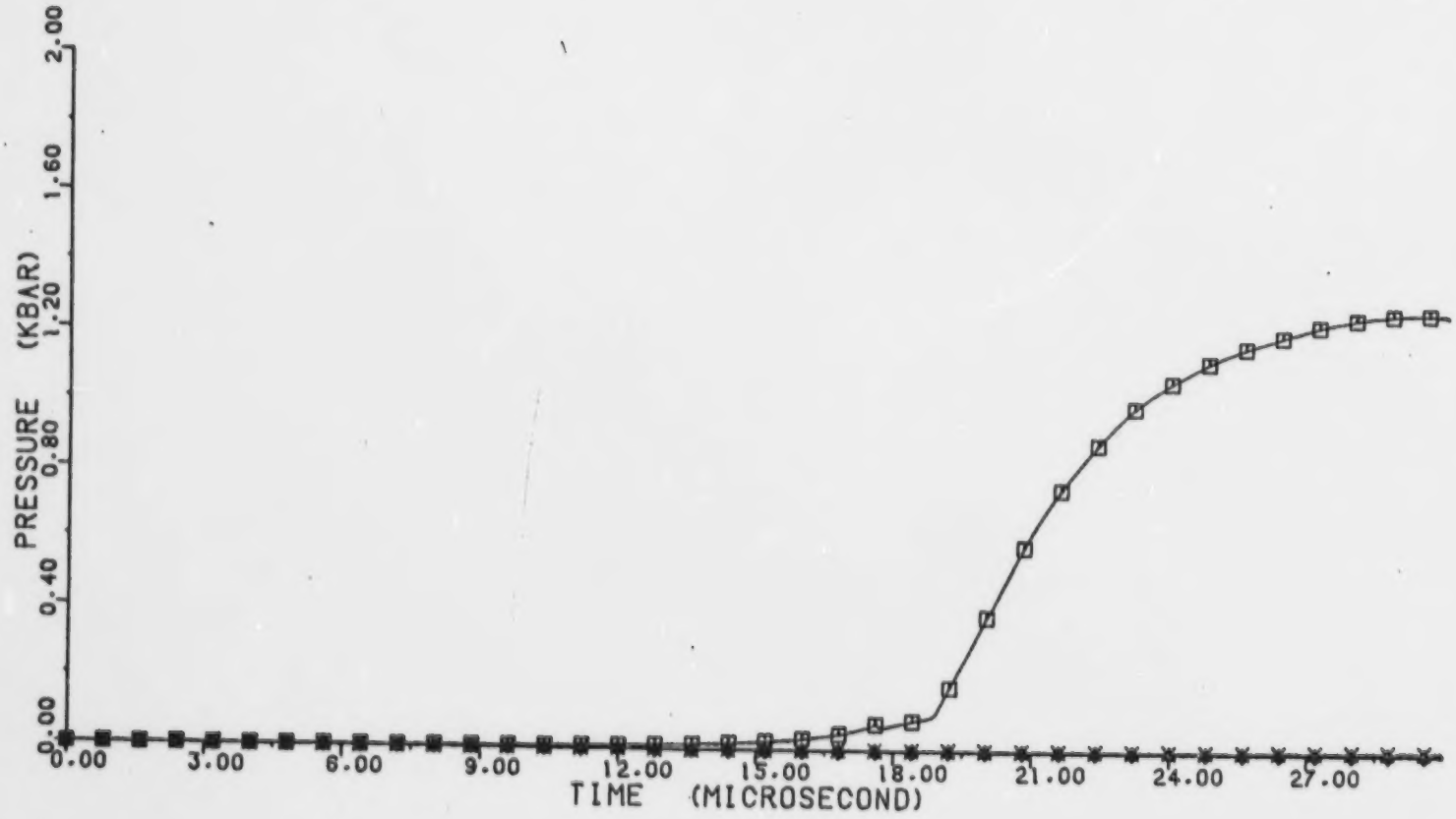

FIGURE 21C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 19)

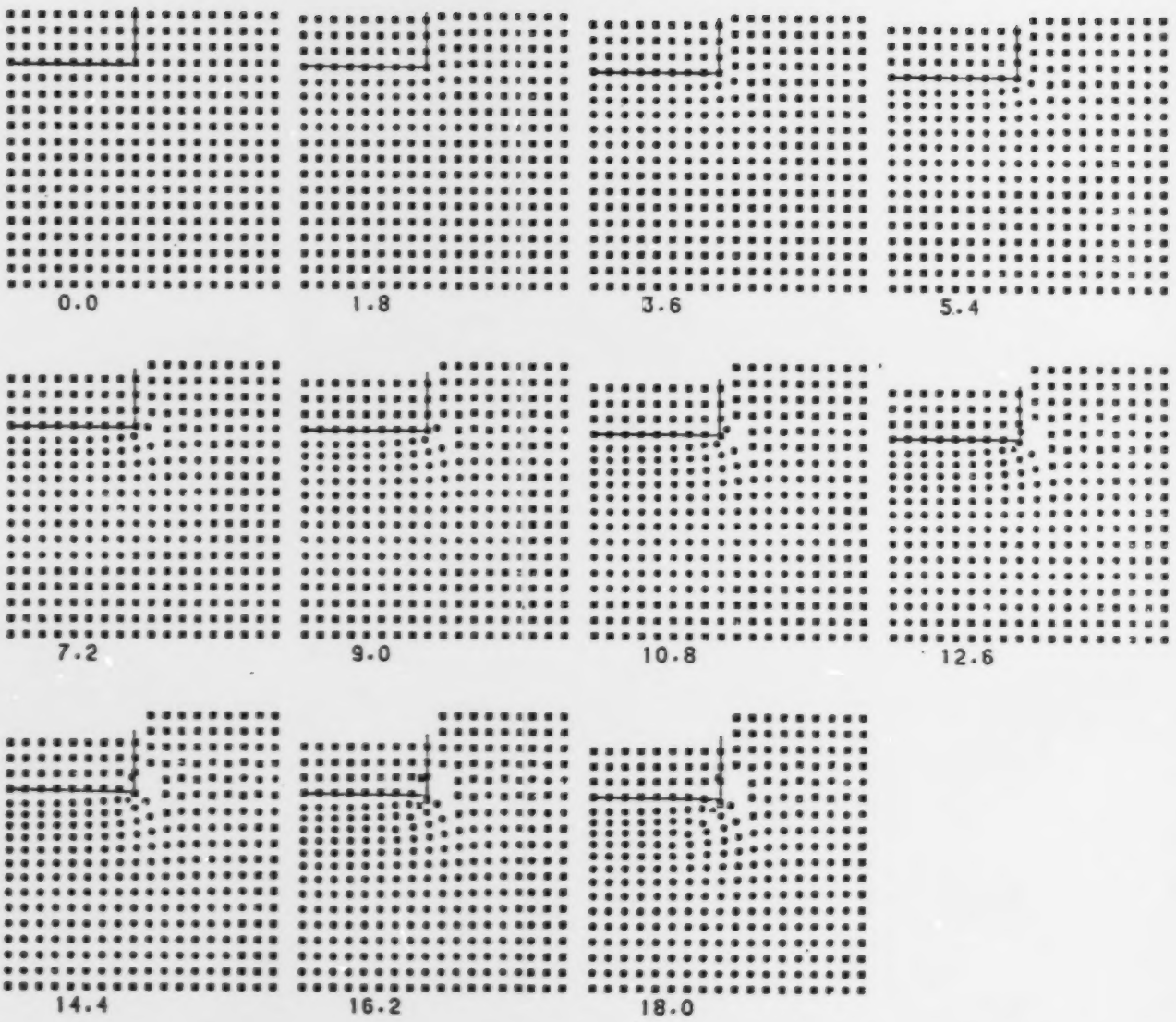

FIGURE 22A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 20)

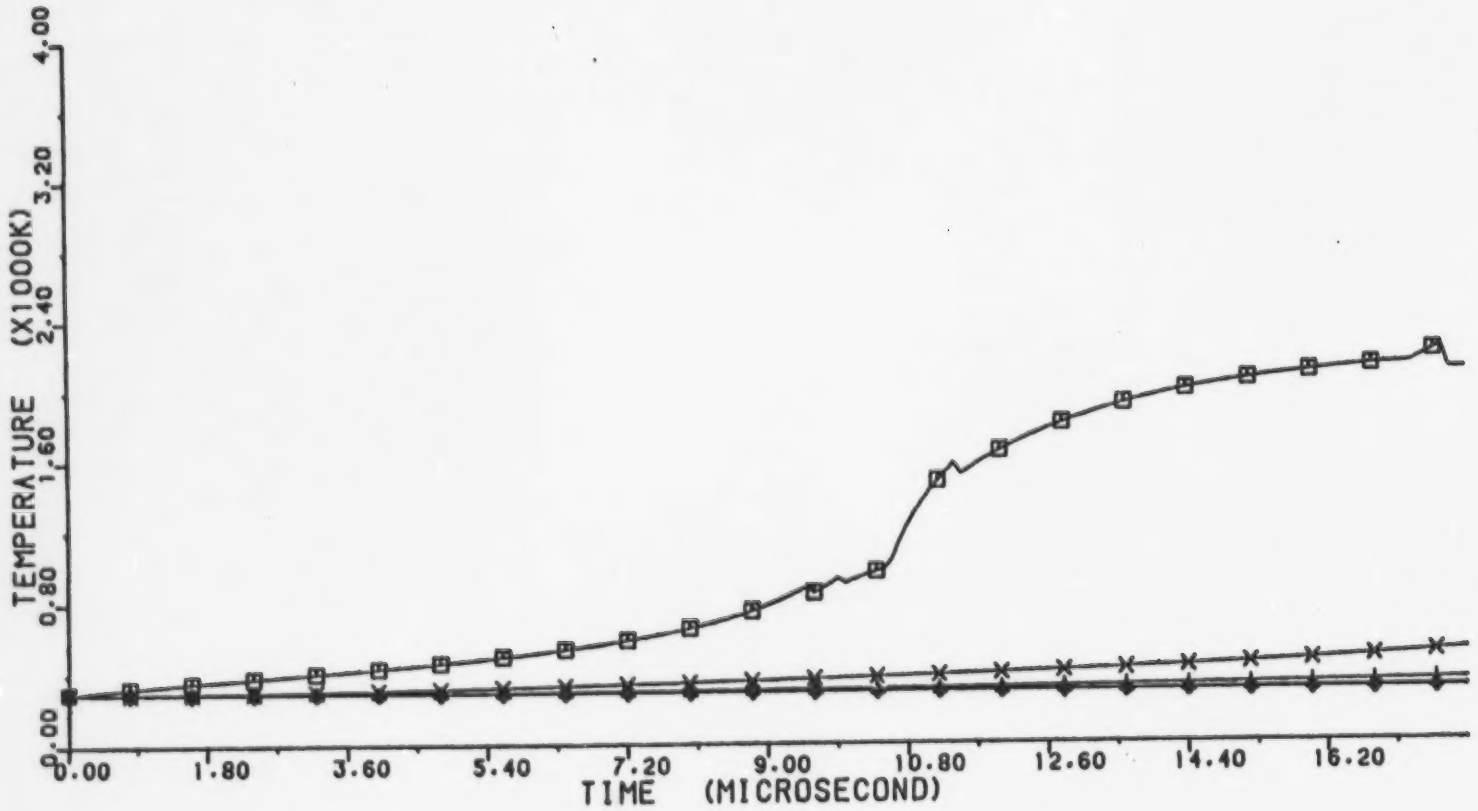

FIGURE 22B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 20)

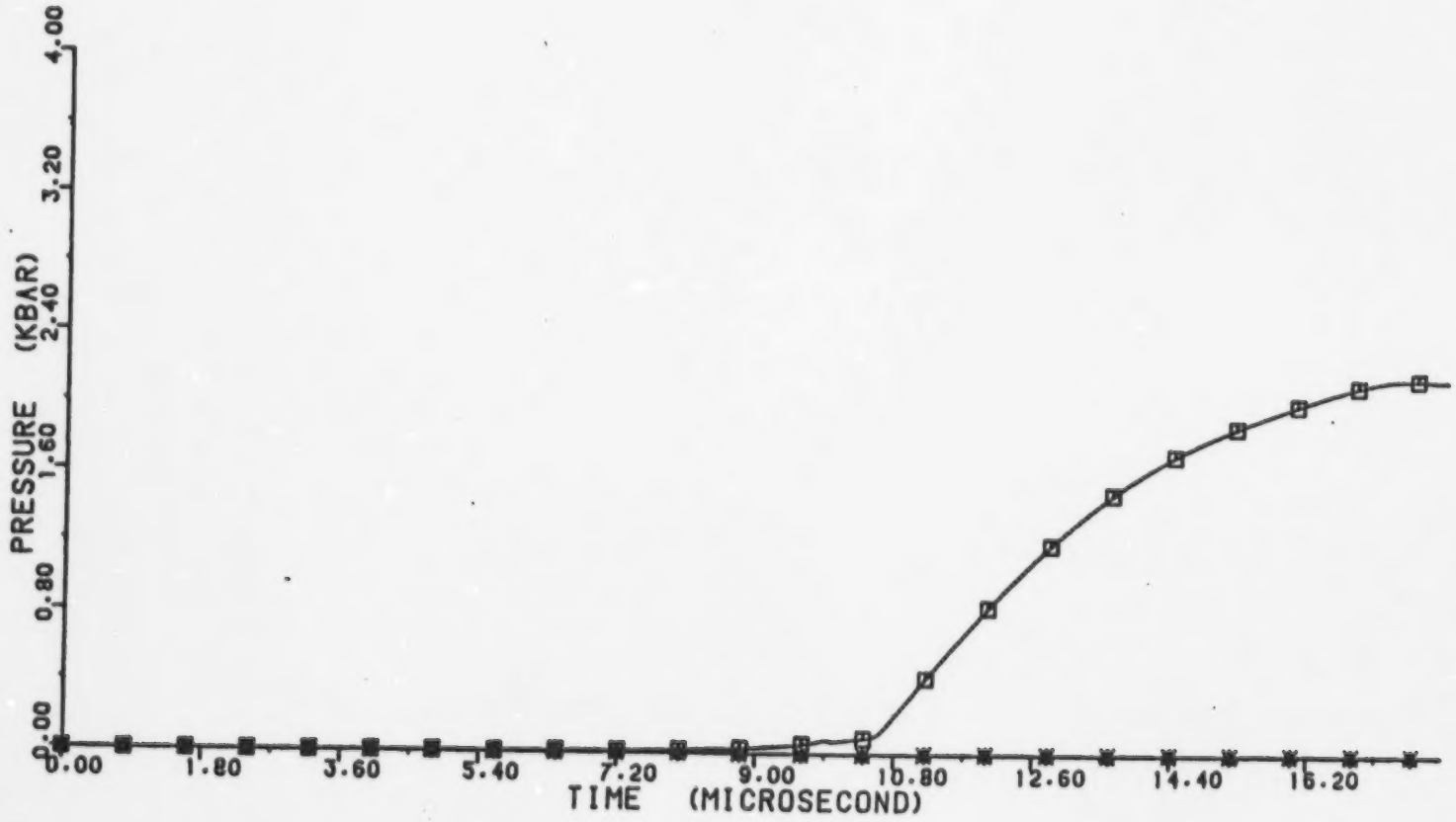

FIGURE 22C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 20)

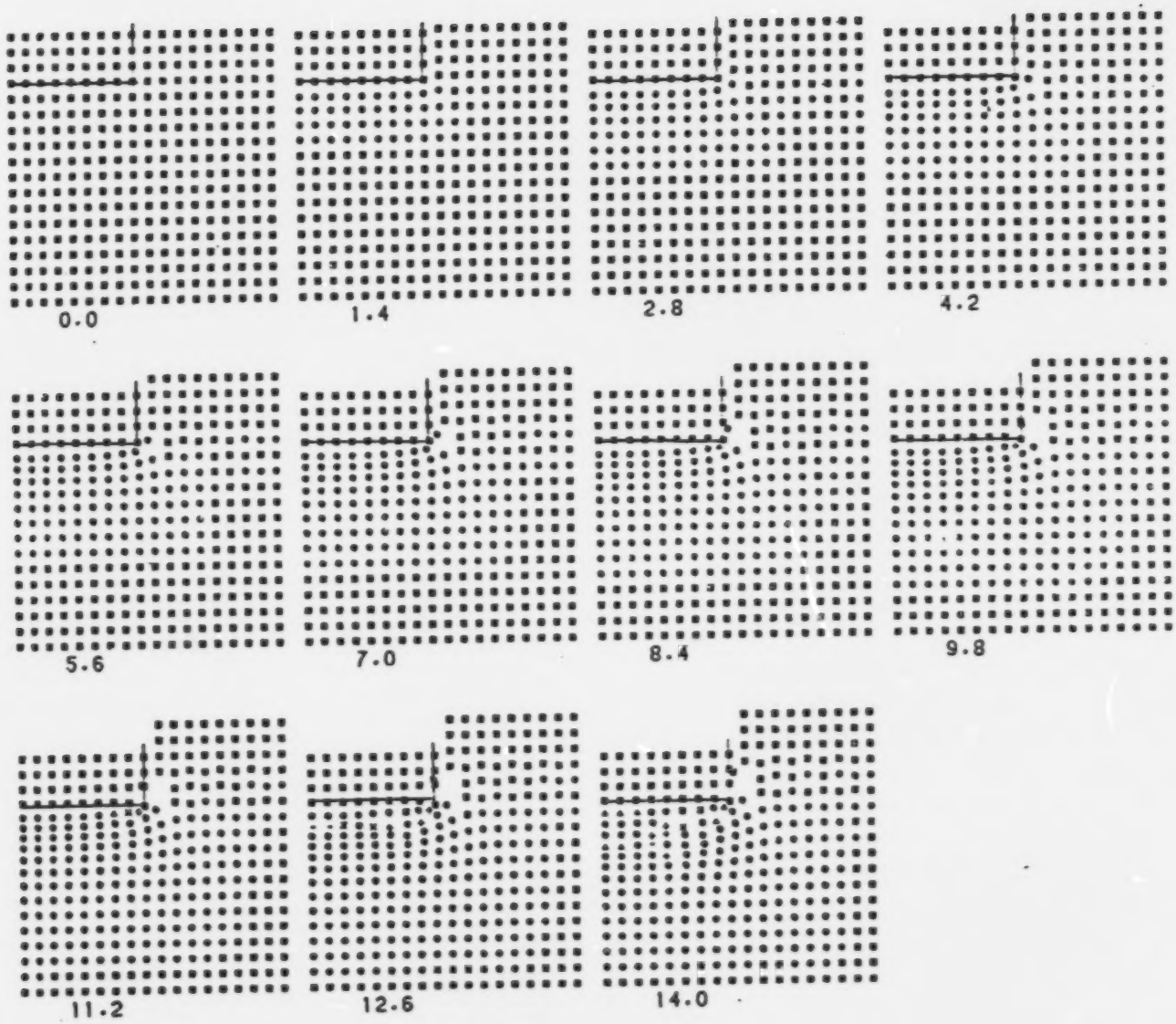

FIGURE 23A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 21)

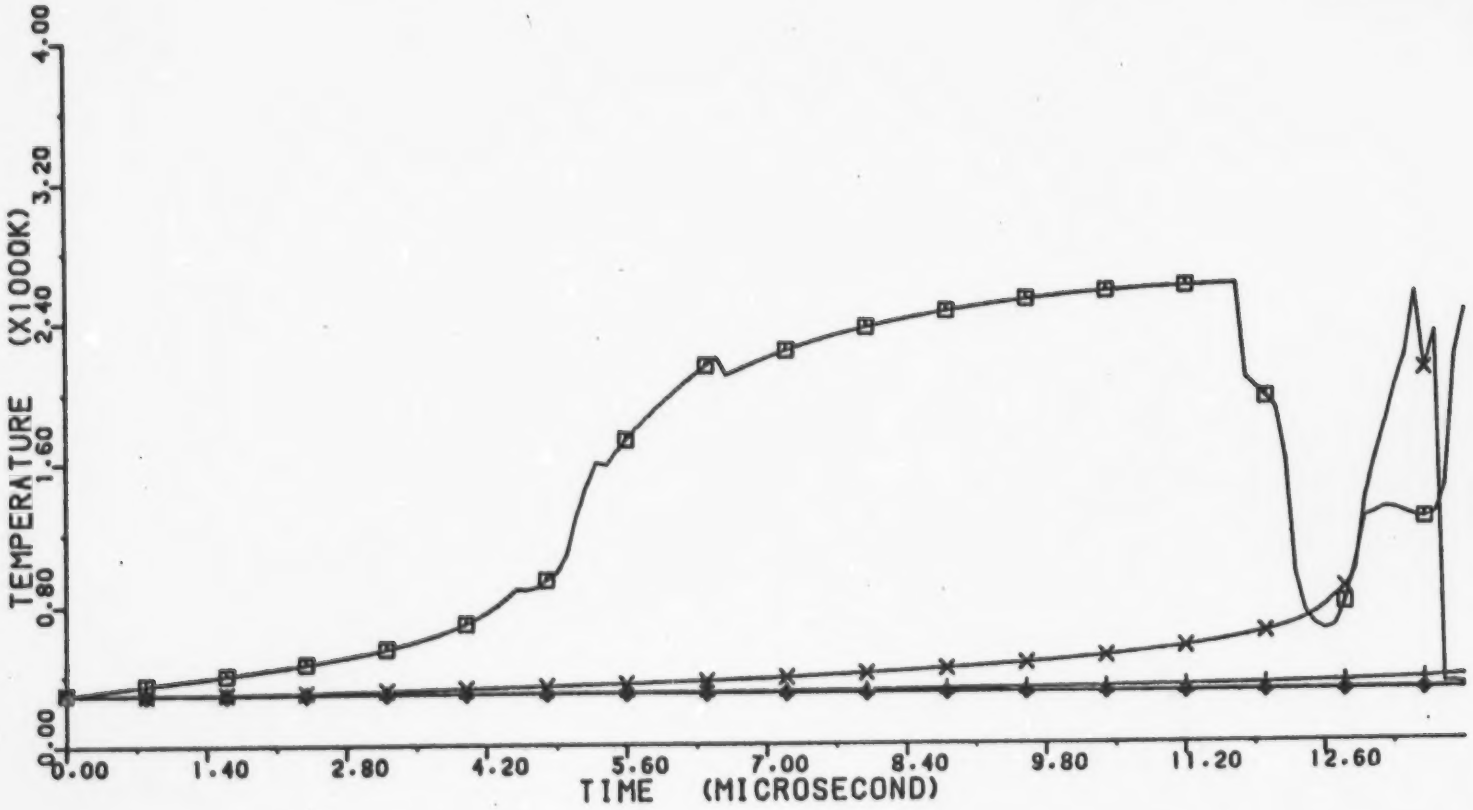

FIGURE 23B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 21)

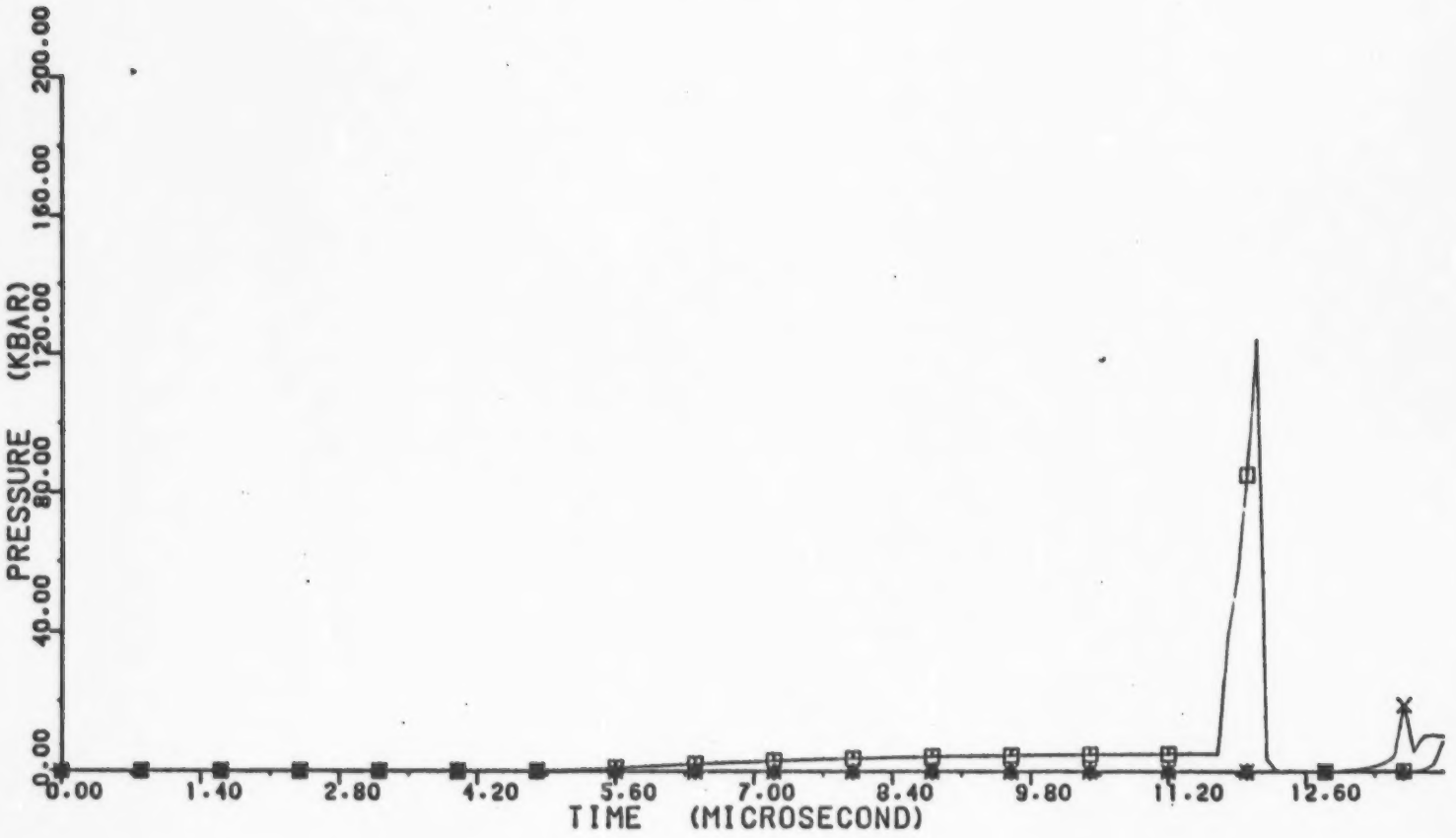

FIGURE 23C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 21)

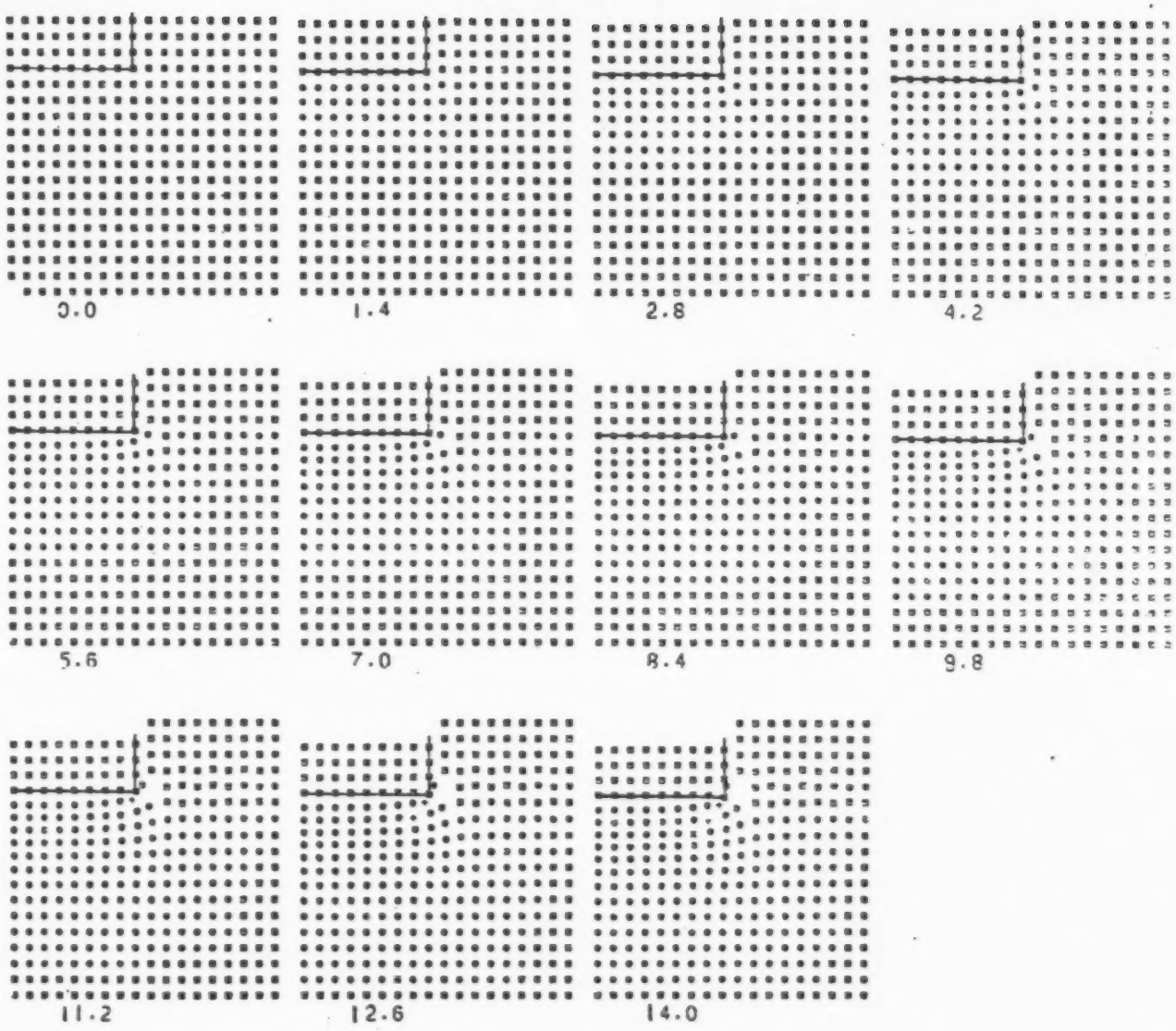

FIGURE 24A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 22)

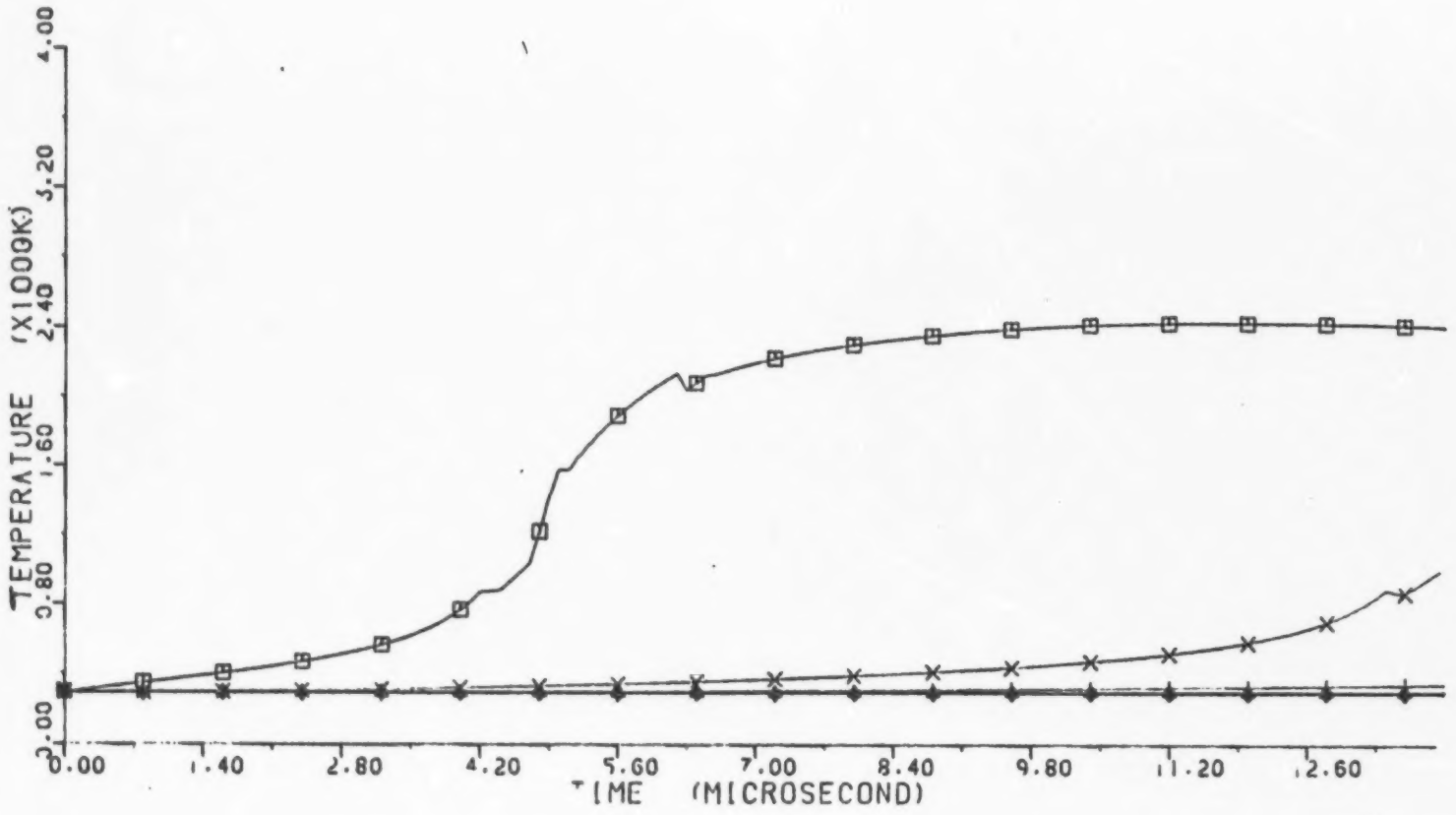

FIGURE 24B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 22)

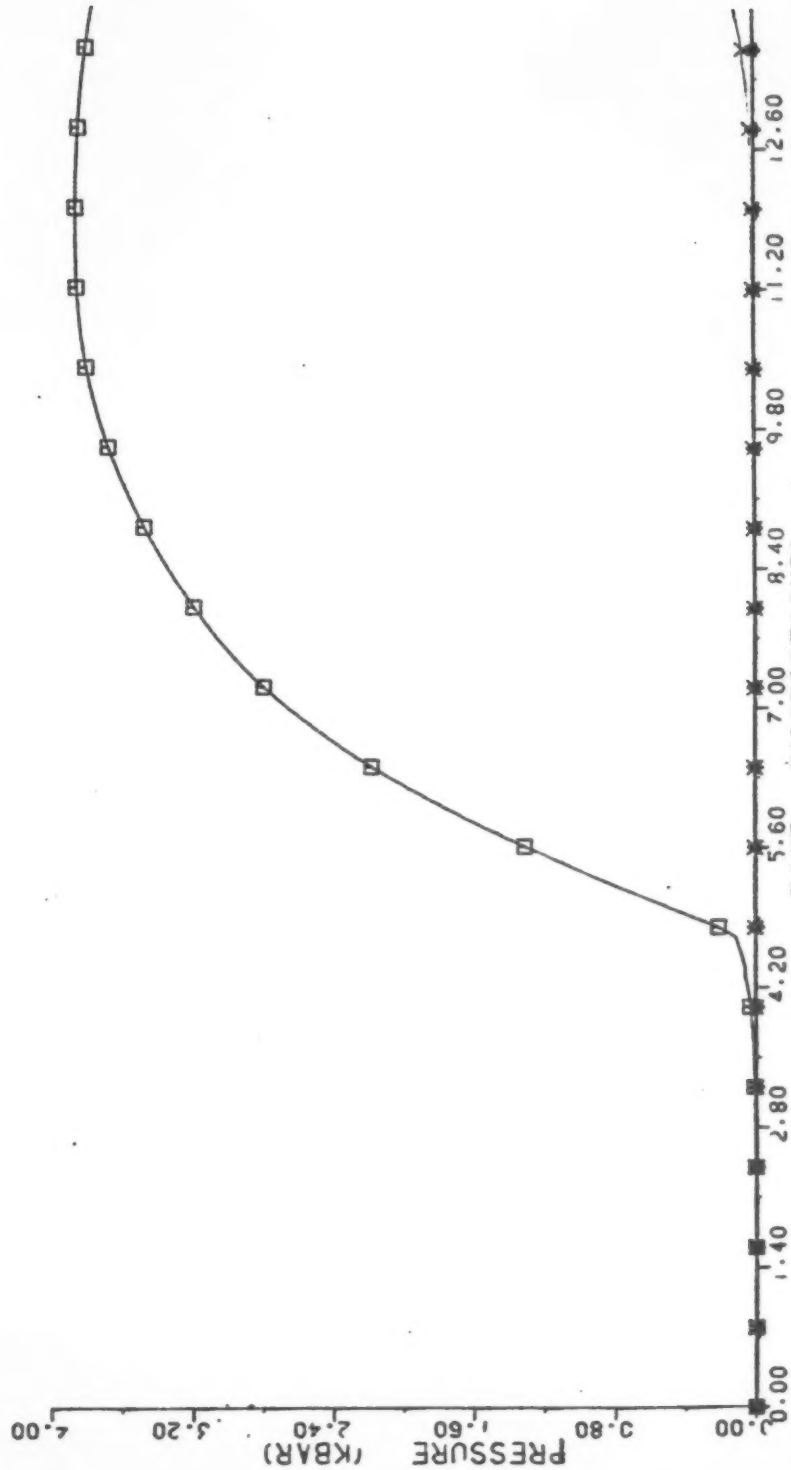

FIGURE 24C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 22)

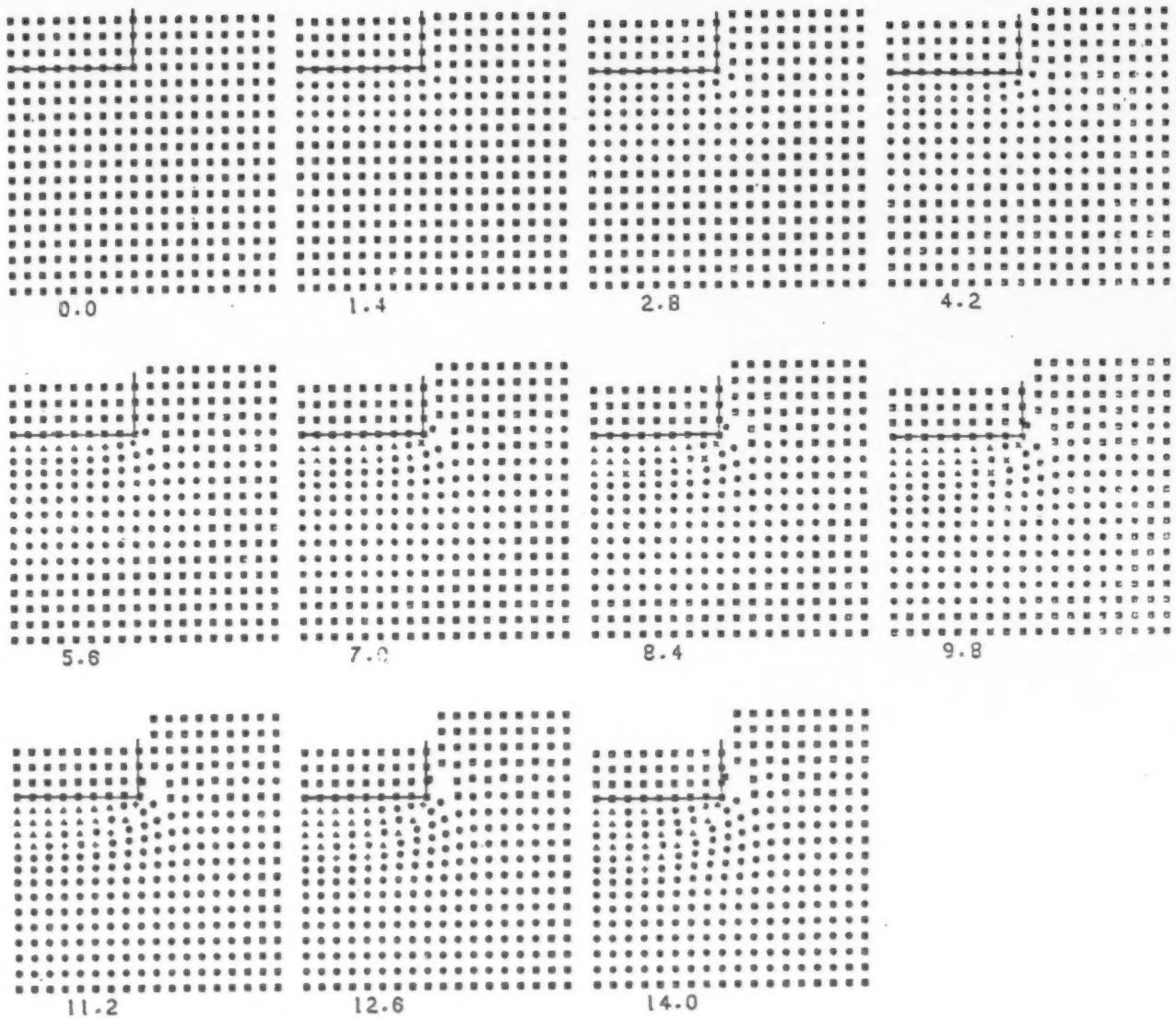

FIGURE 25A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 23)

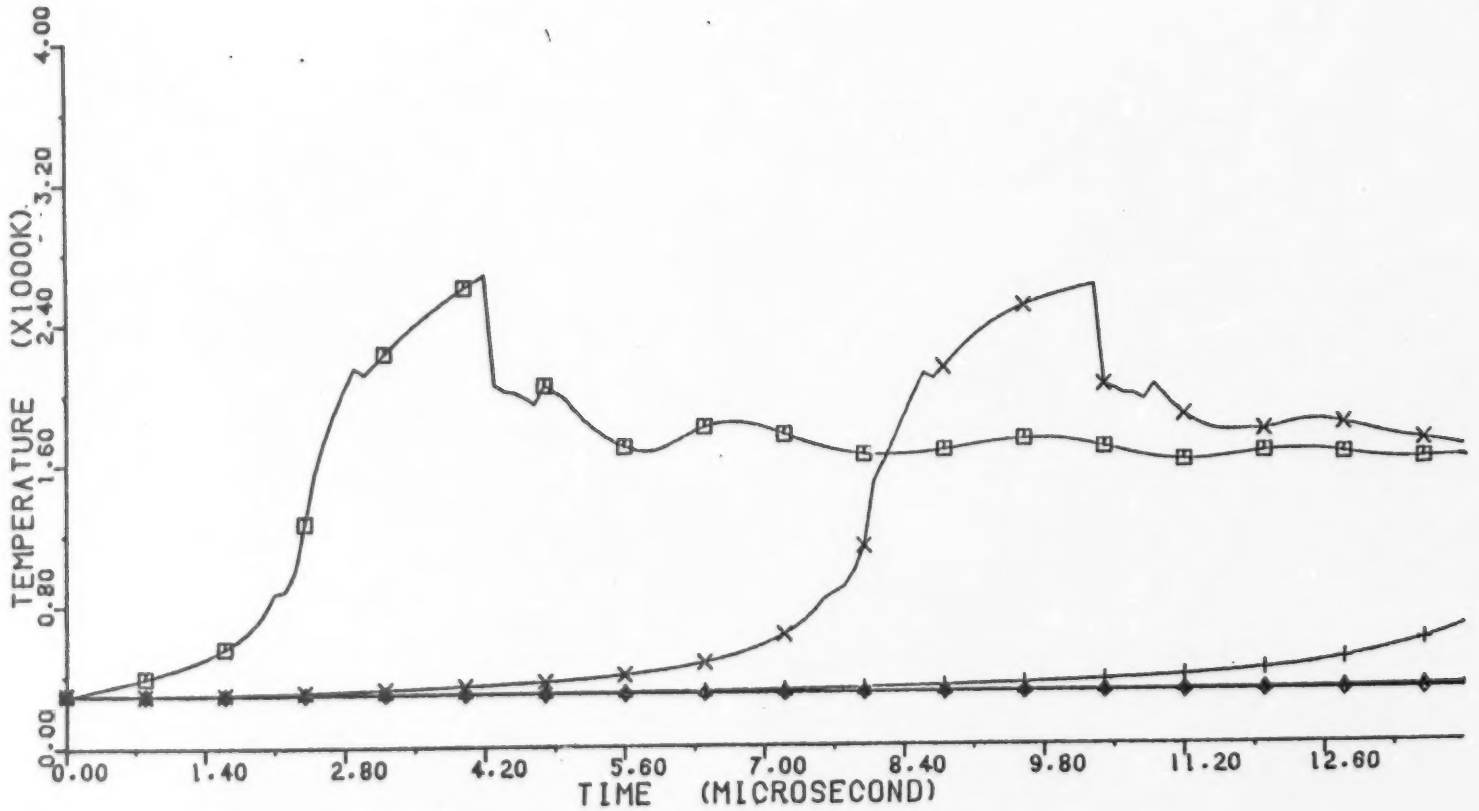

FIGURE 25B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 23)

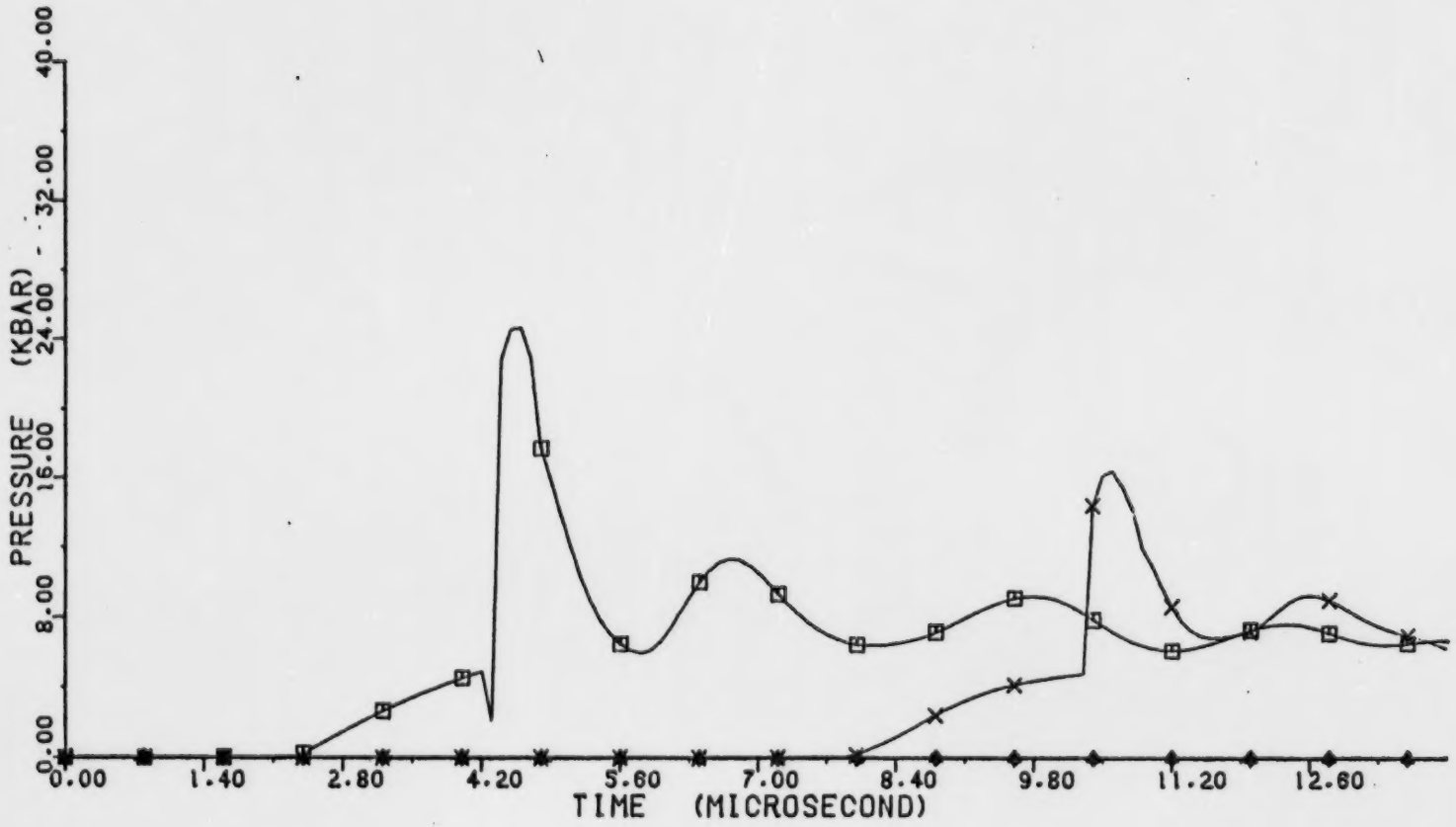

FIGURE 25C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 23)

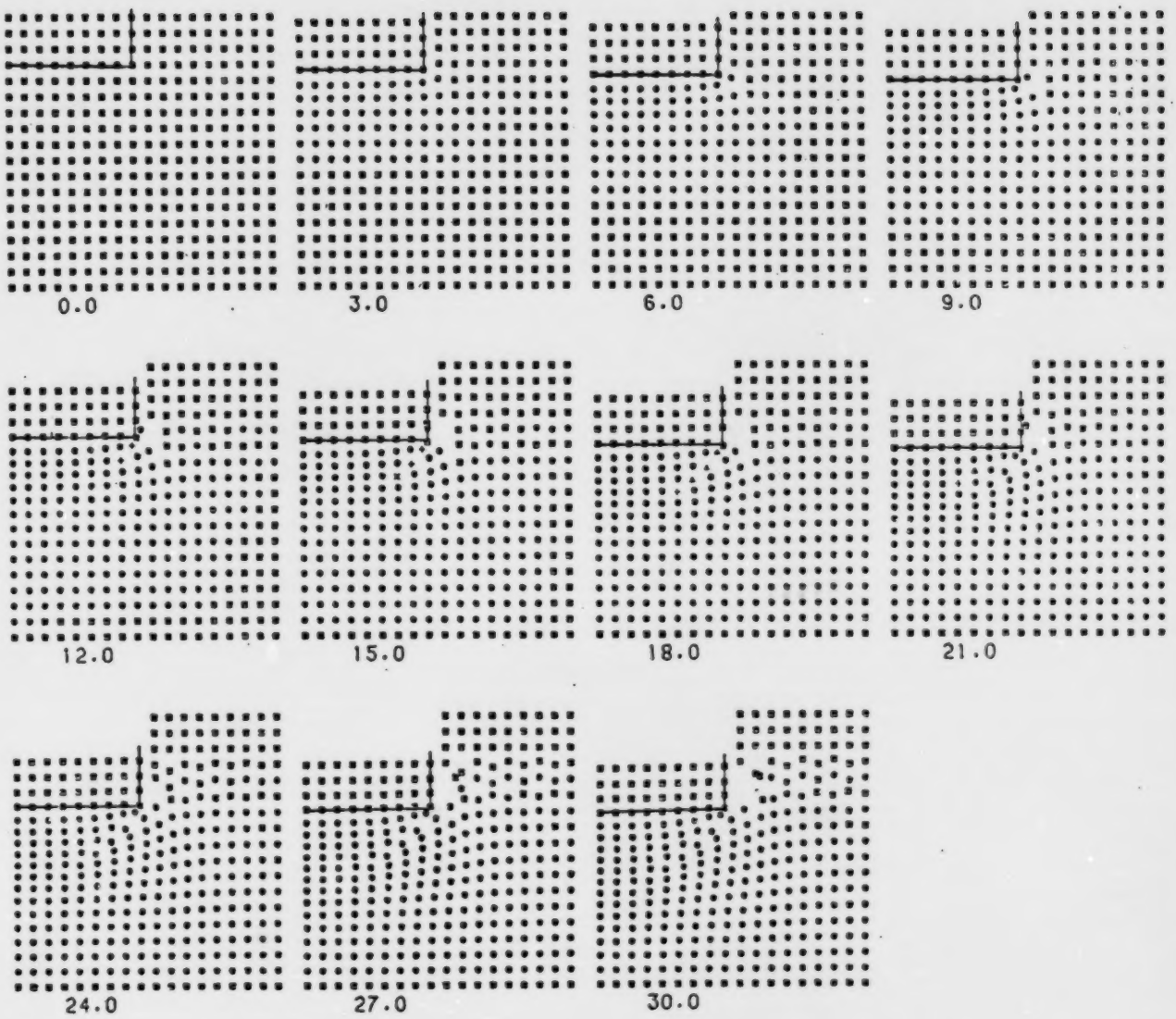

FIGURE 26A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 24)

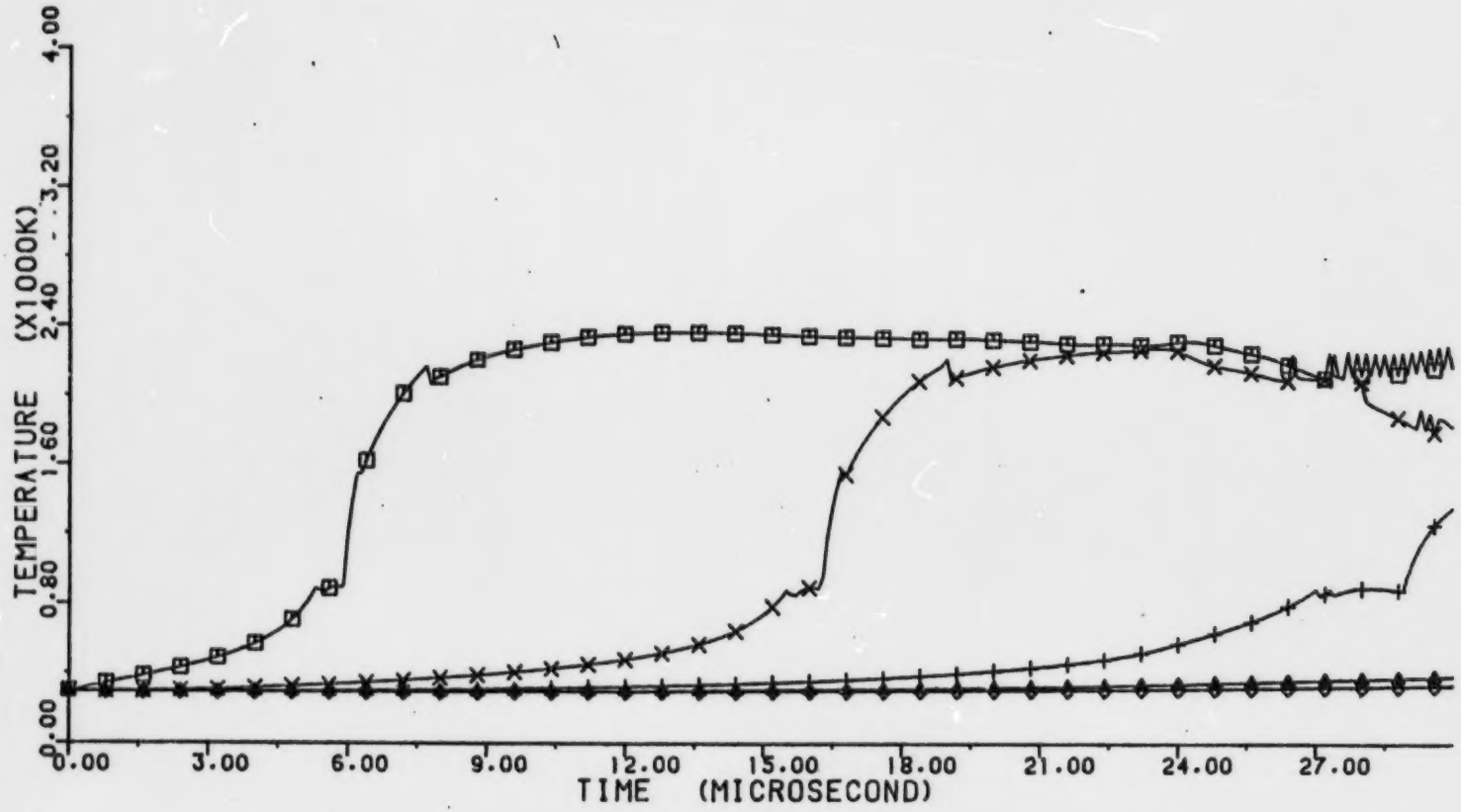

FIGURE 26B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 24)

FIGURE 26C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 24)

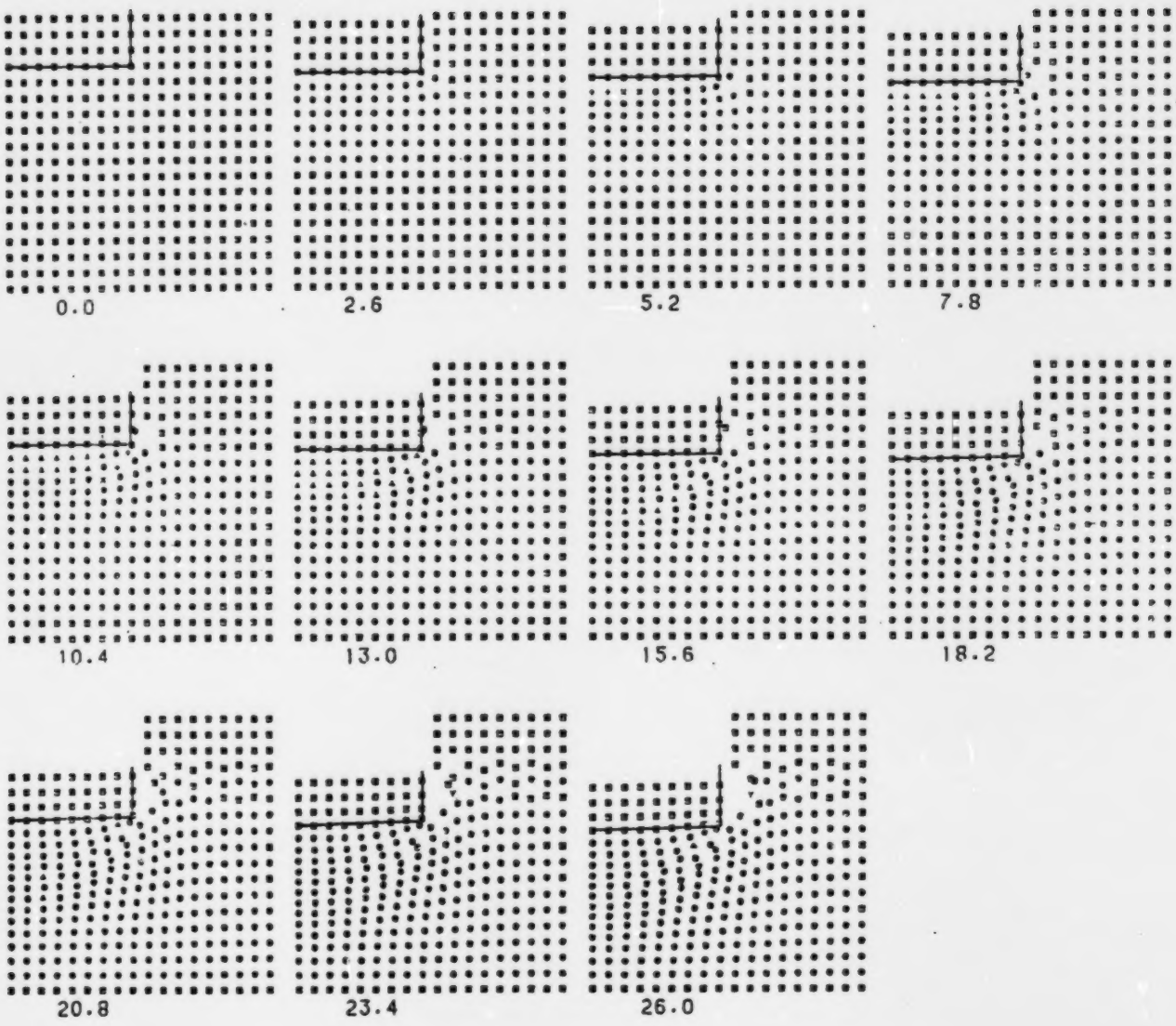

FIGURE 27A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 25)

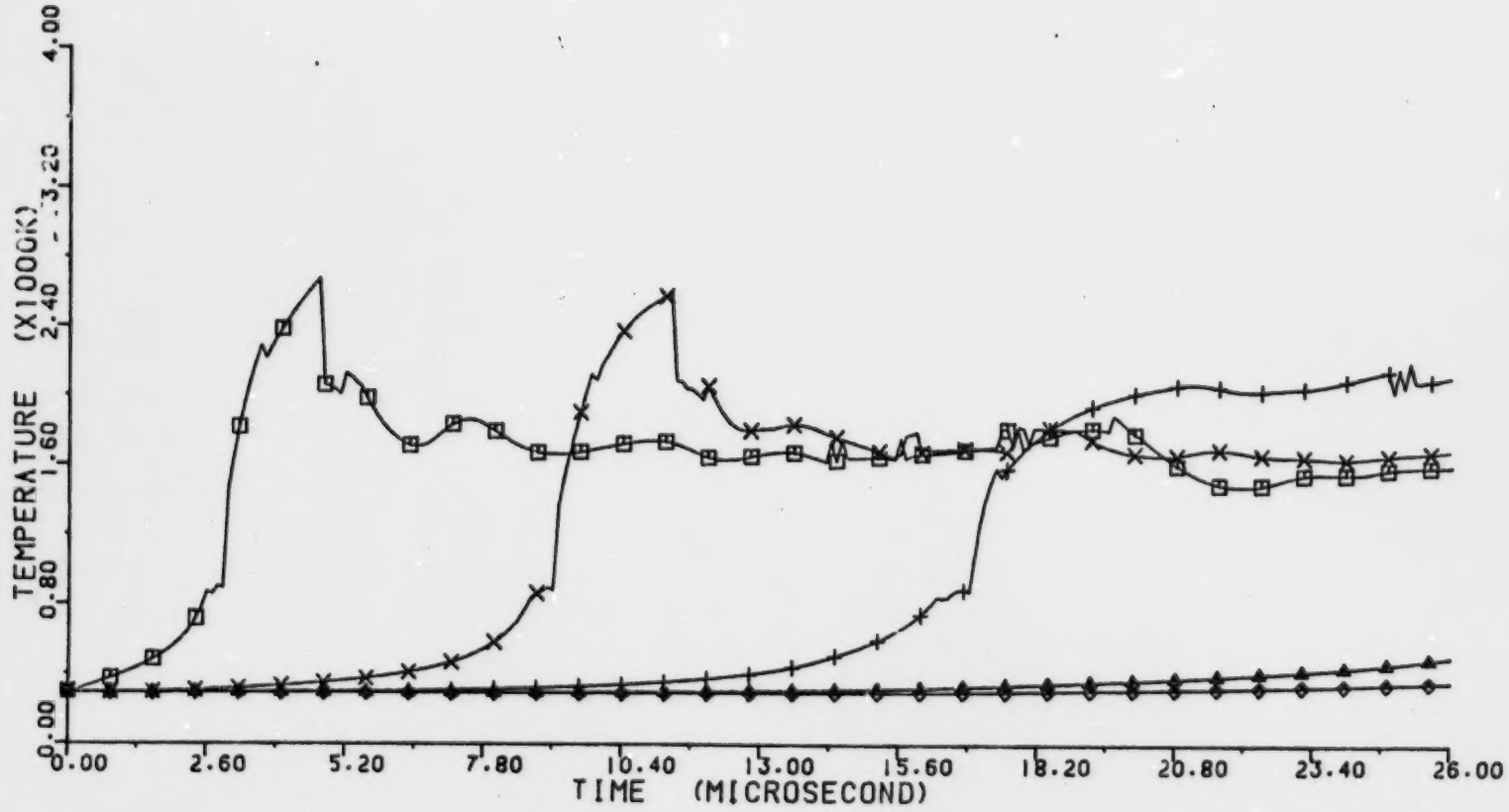

FIGURE 27B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 25)

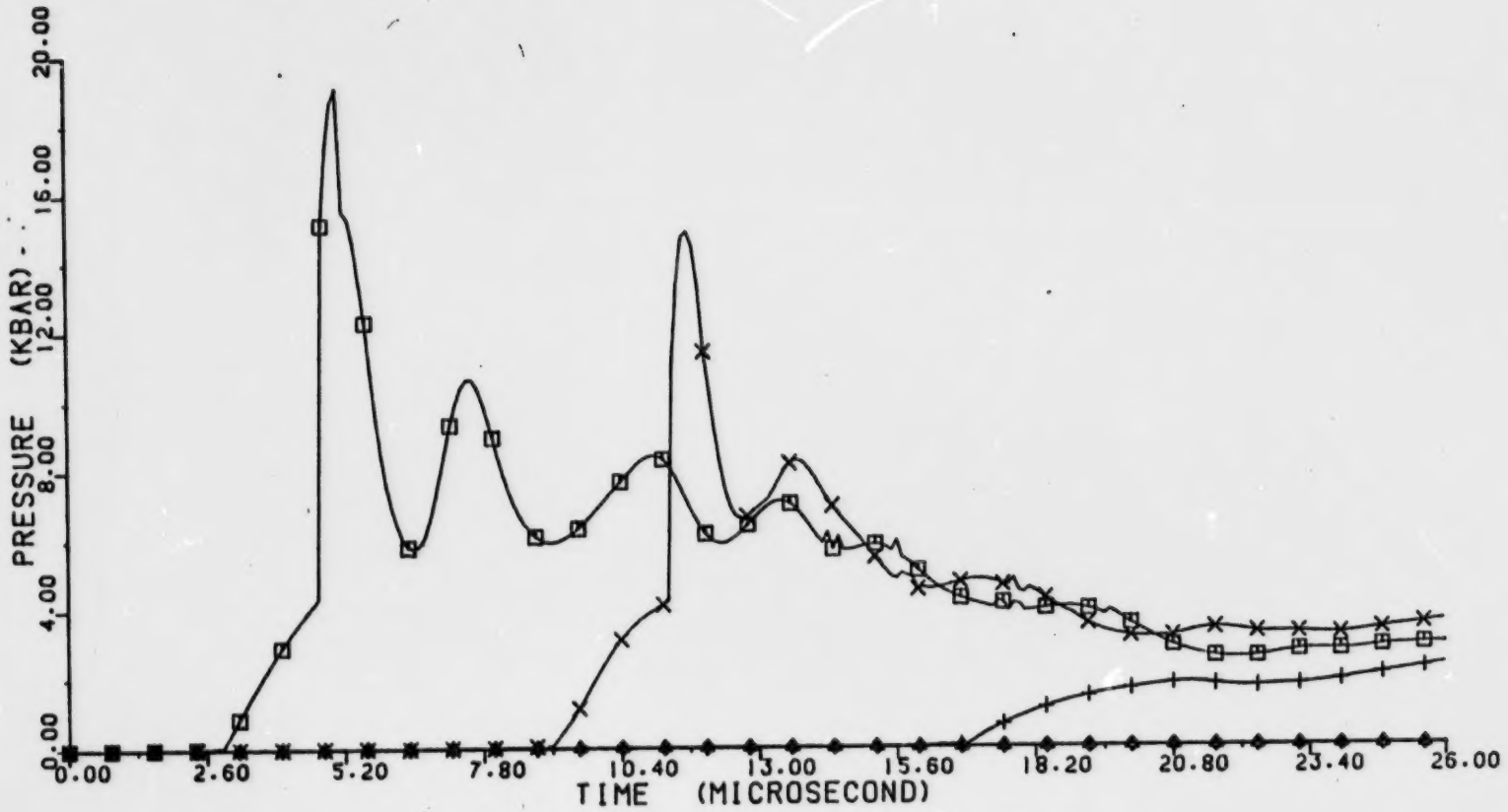

FIGURE 27C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 25)

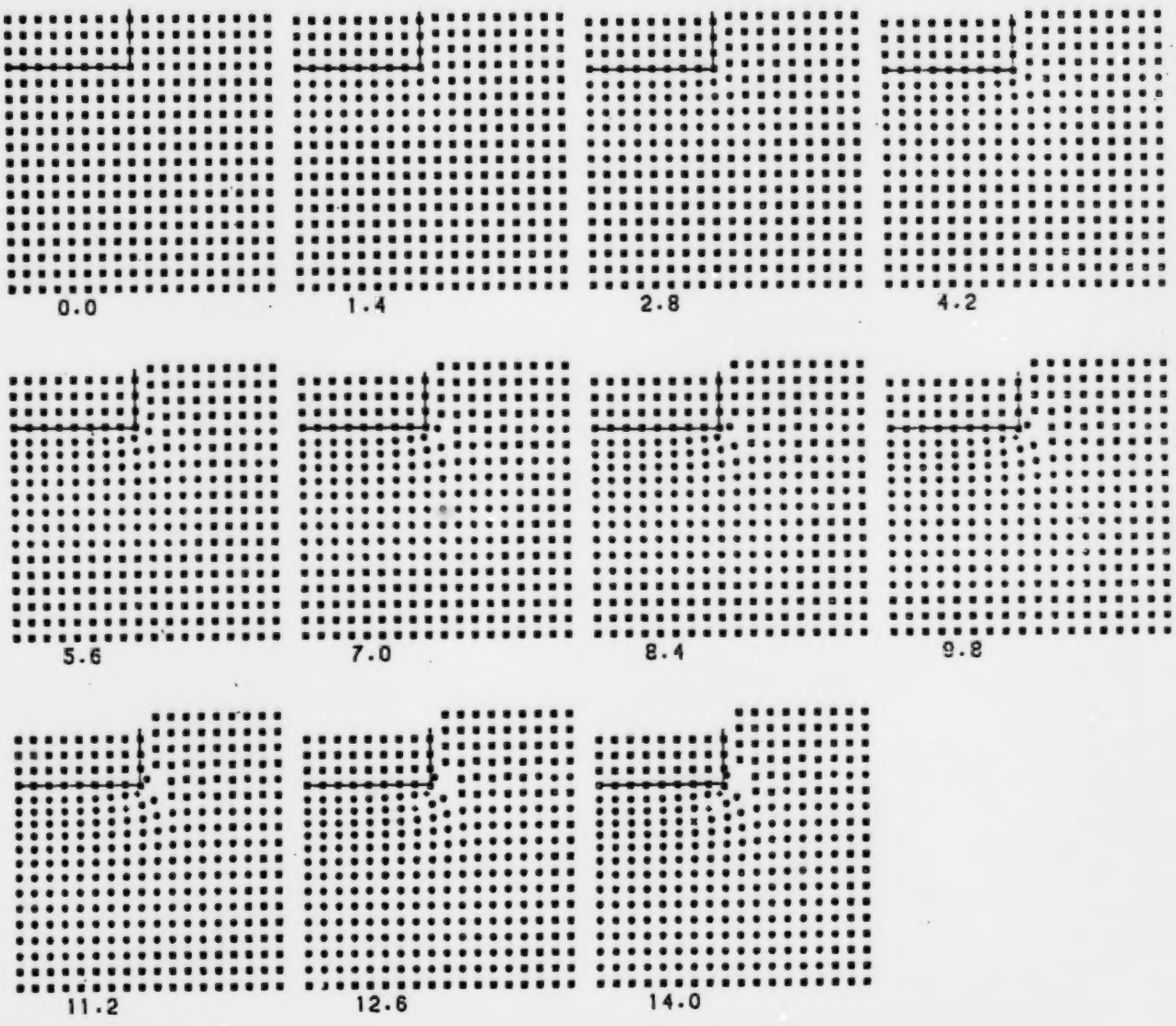

FIGURE 28A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 26)

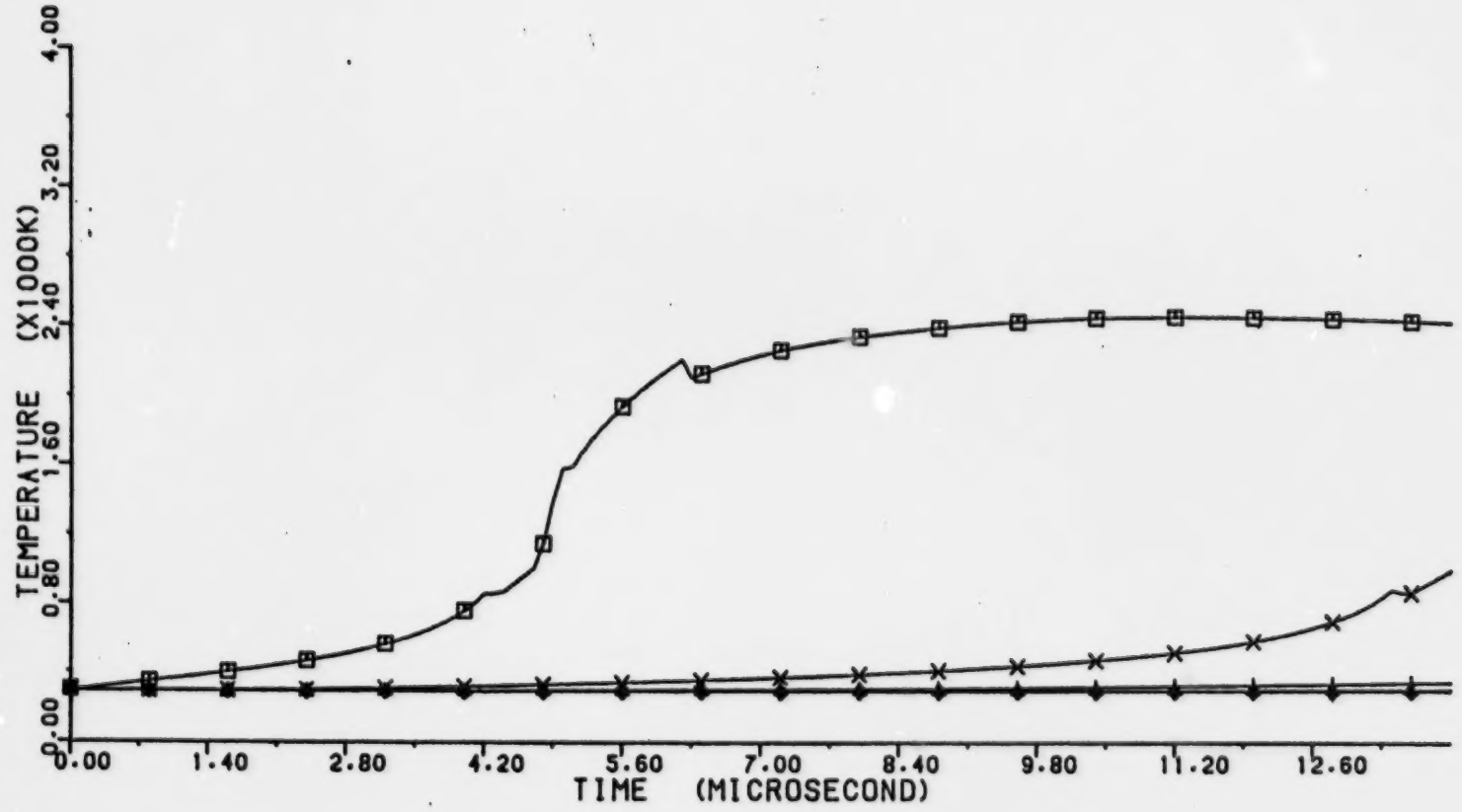

FIGURE 28B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 26)

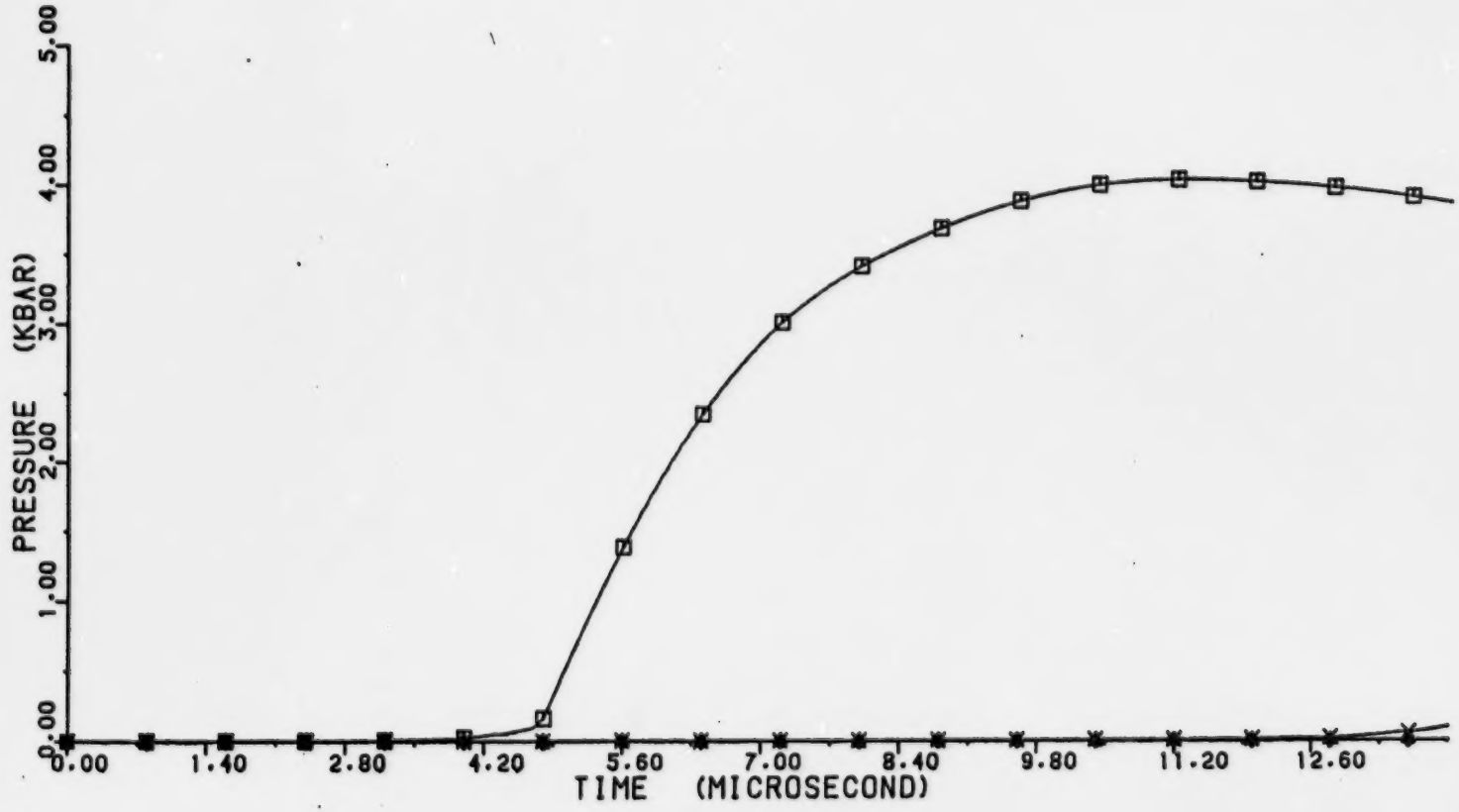

FIGURE 28C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 26)

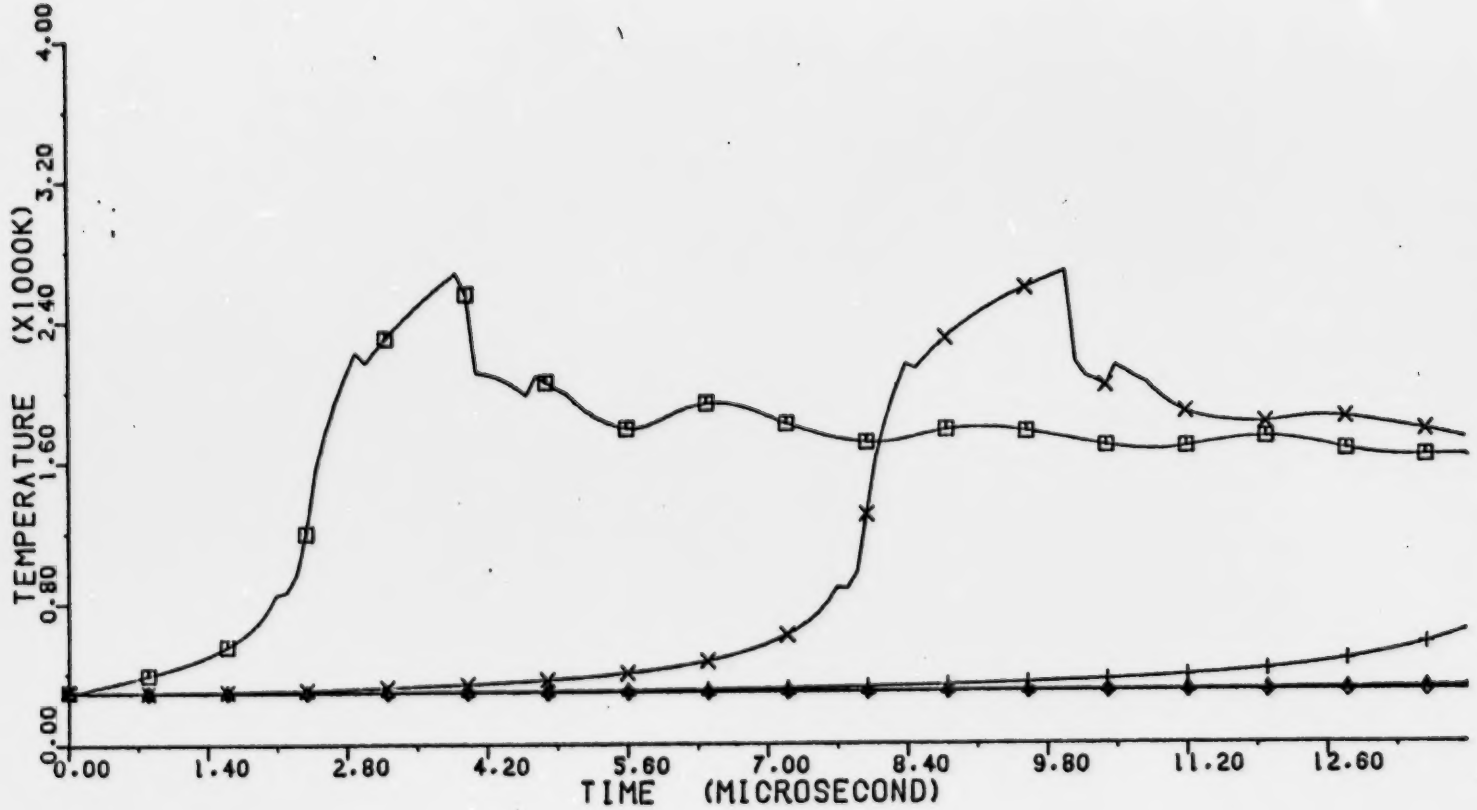

FIGURE 29B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 27)

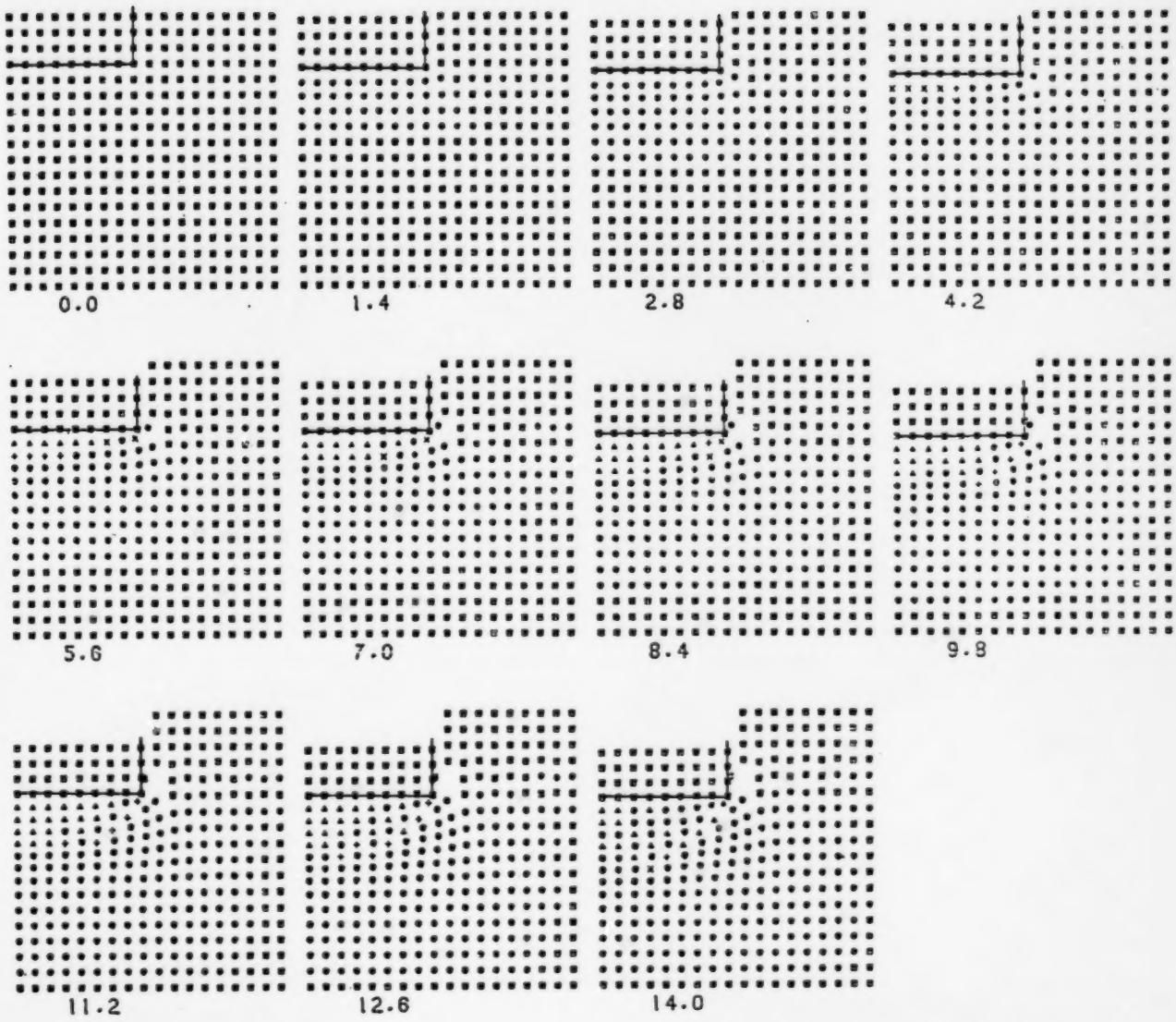

FIGURE 29A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 27)

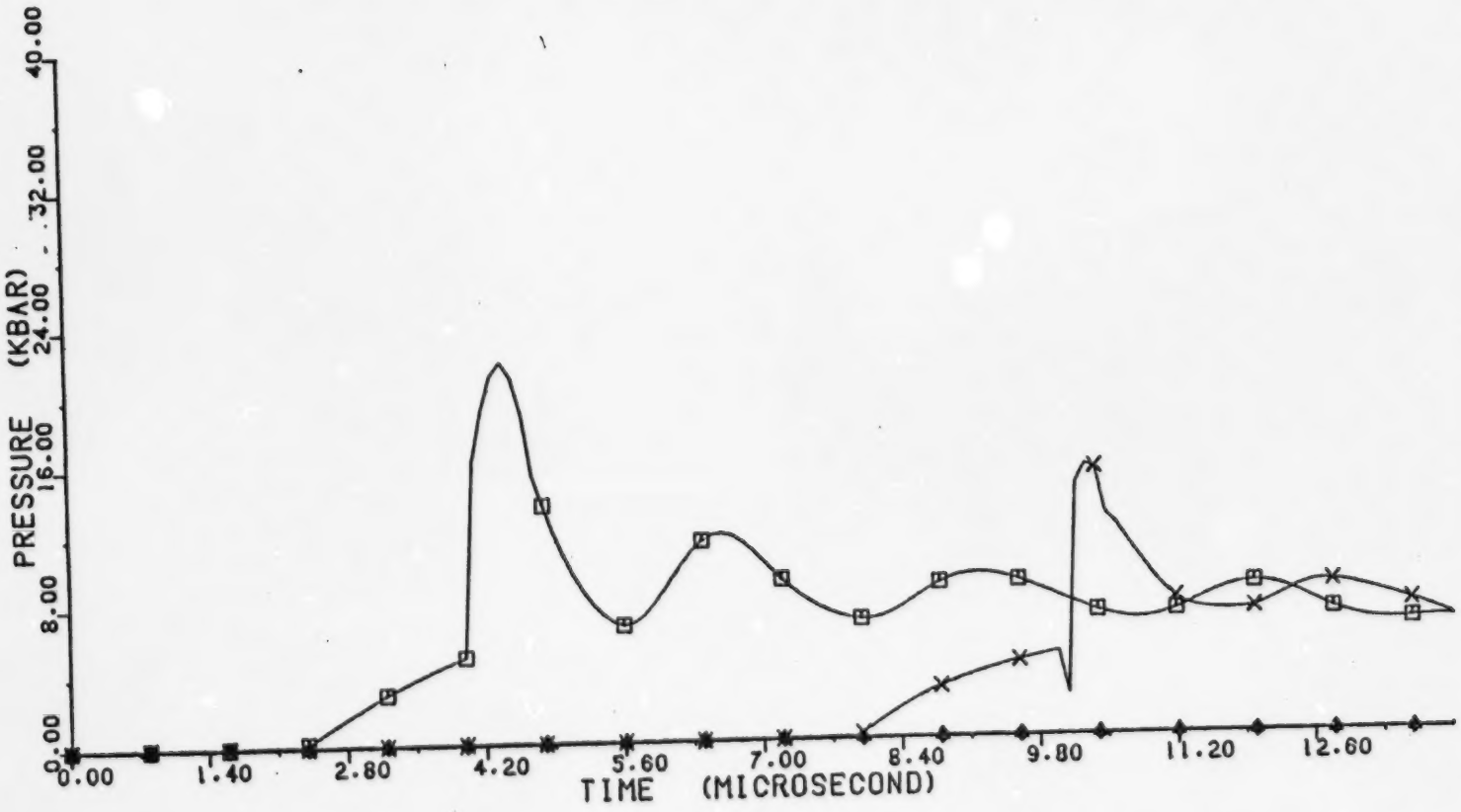

FIGURE 29C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 27)

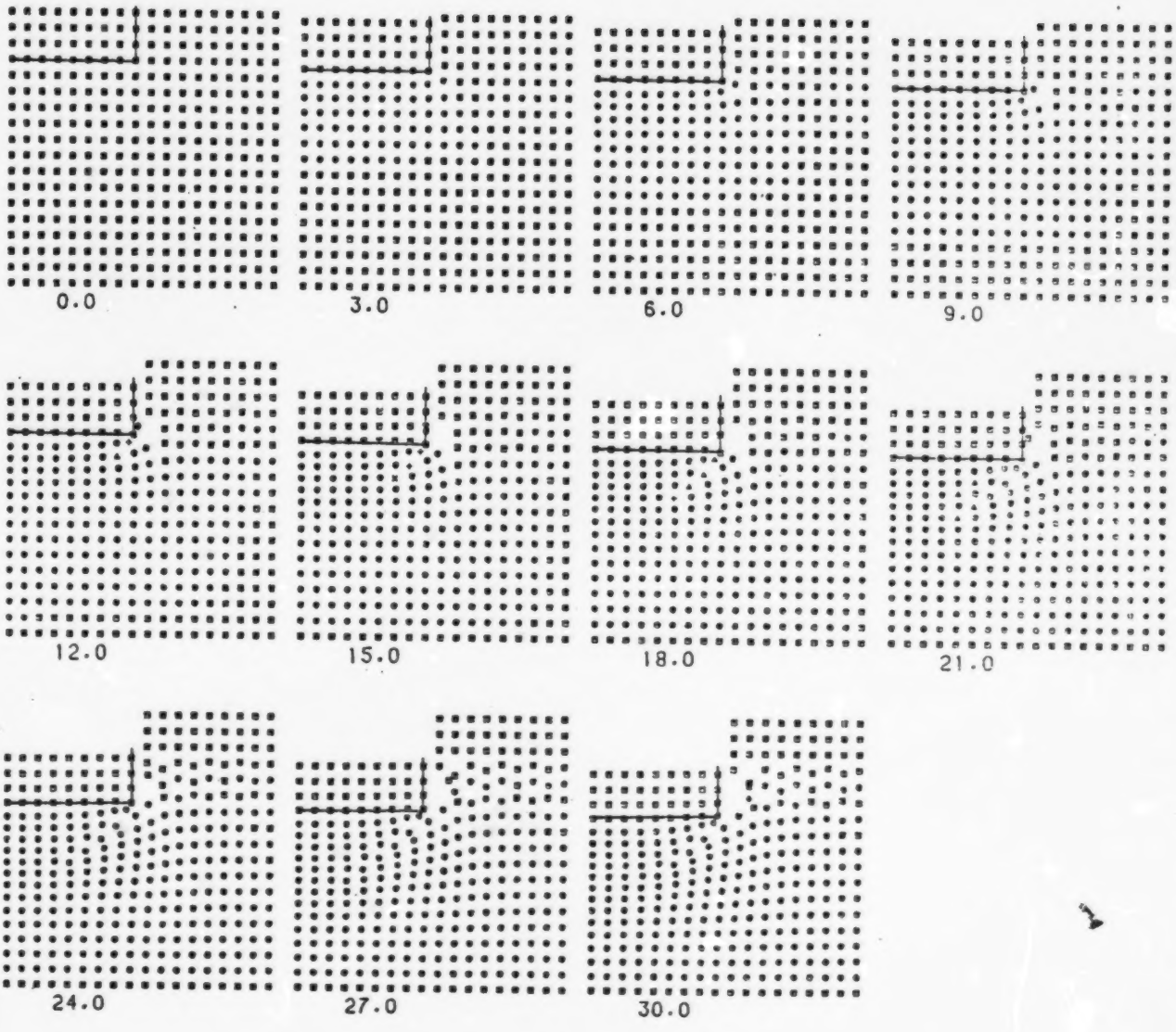

FIGURE 30A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 28)

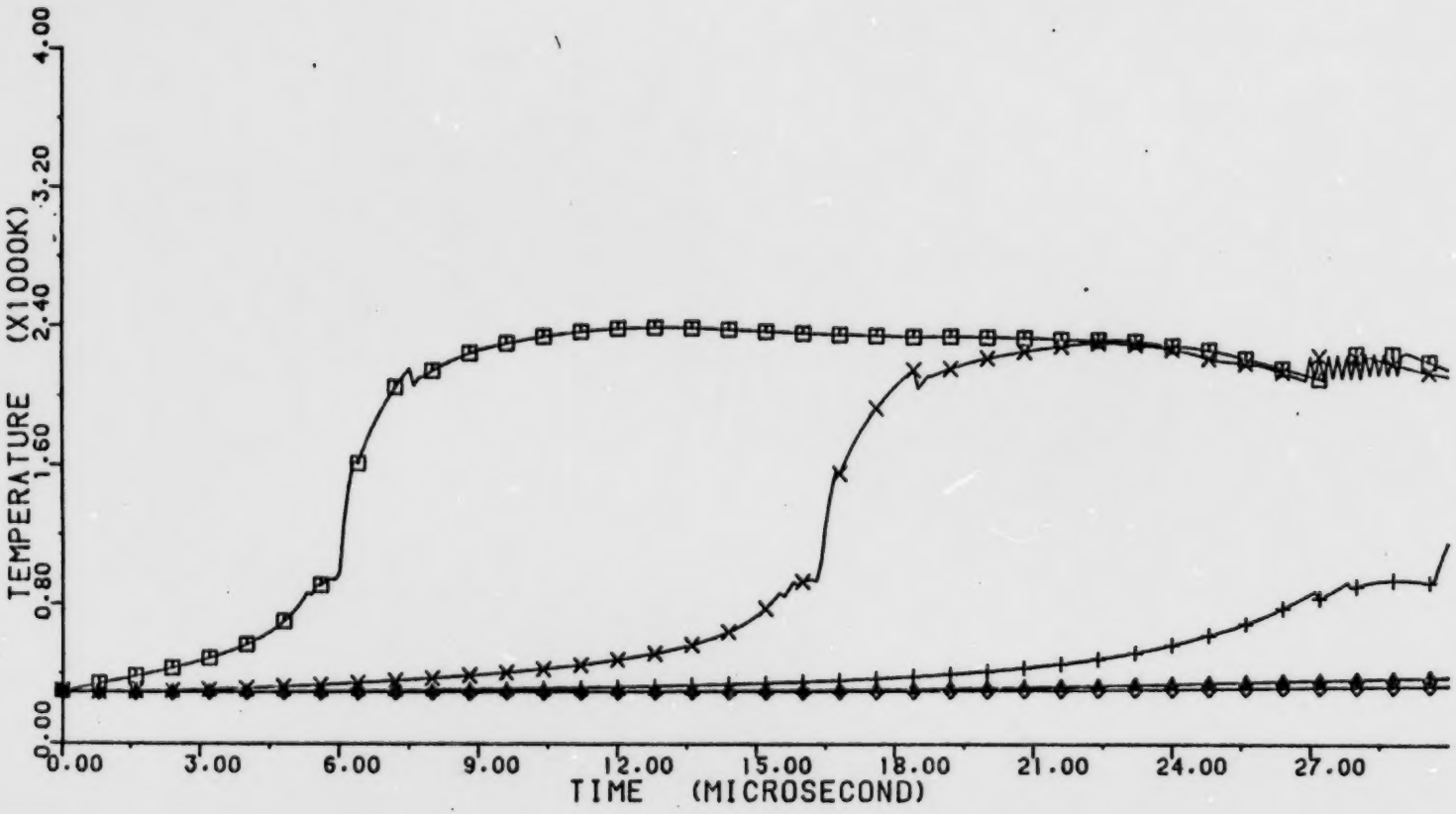

FIGURE 30B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 28)

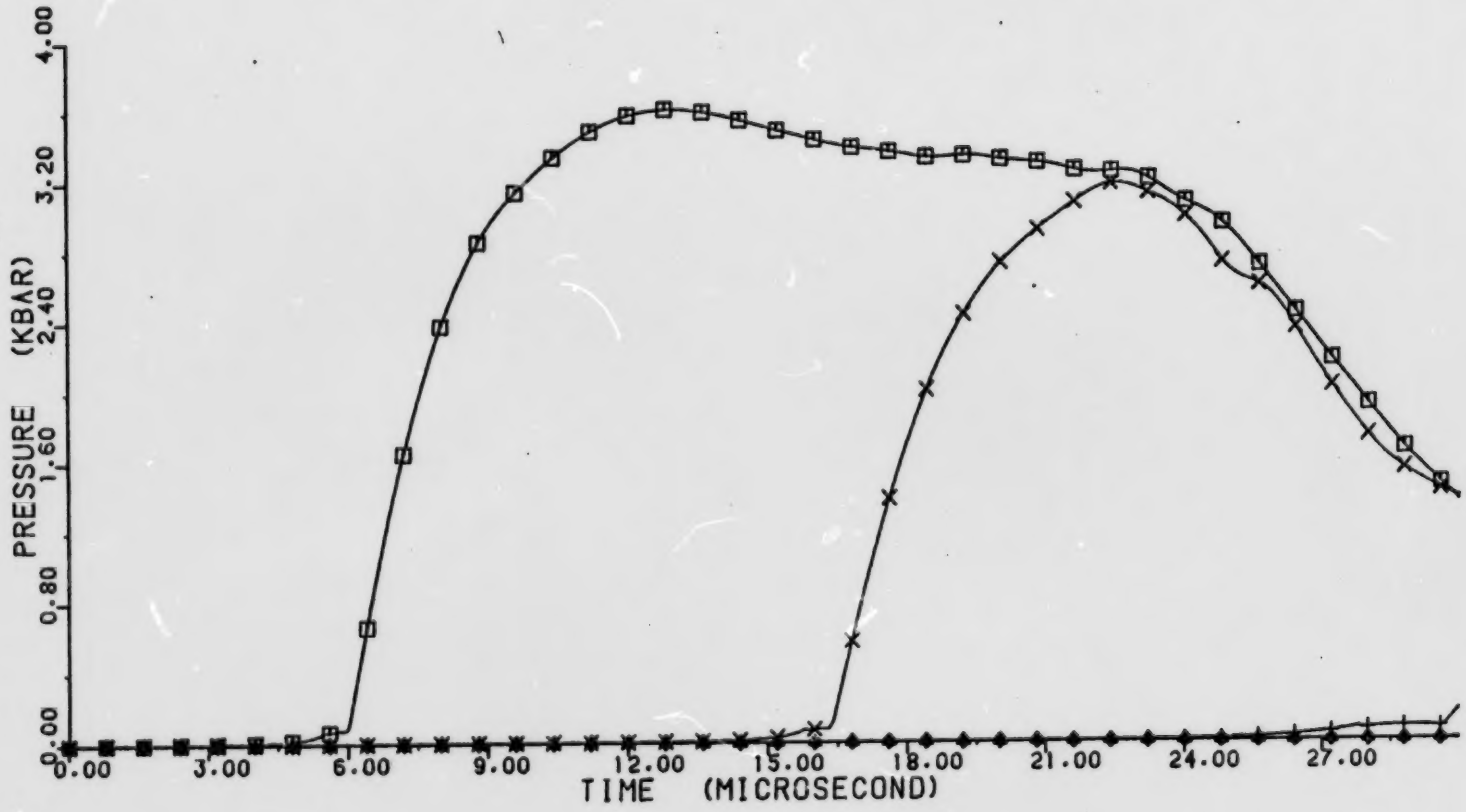

FIGURE 30C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 28)

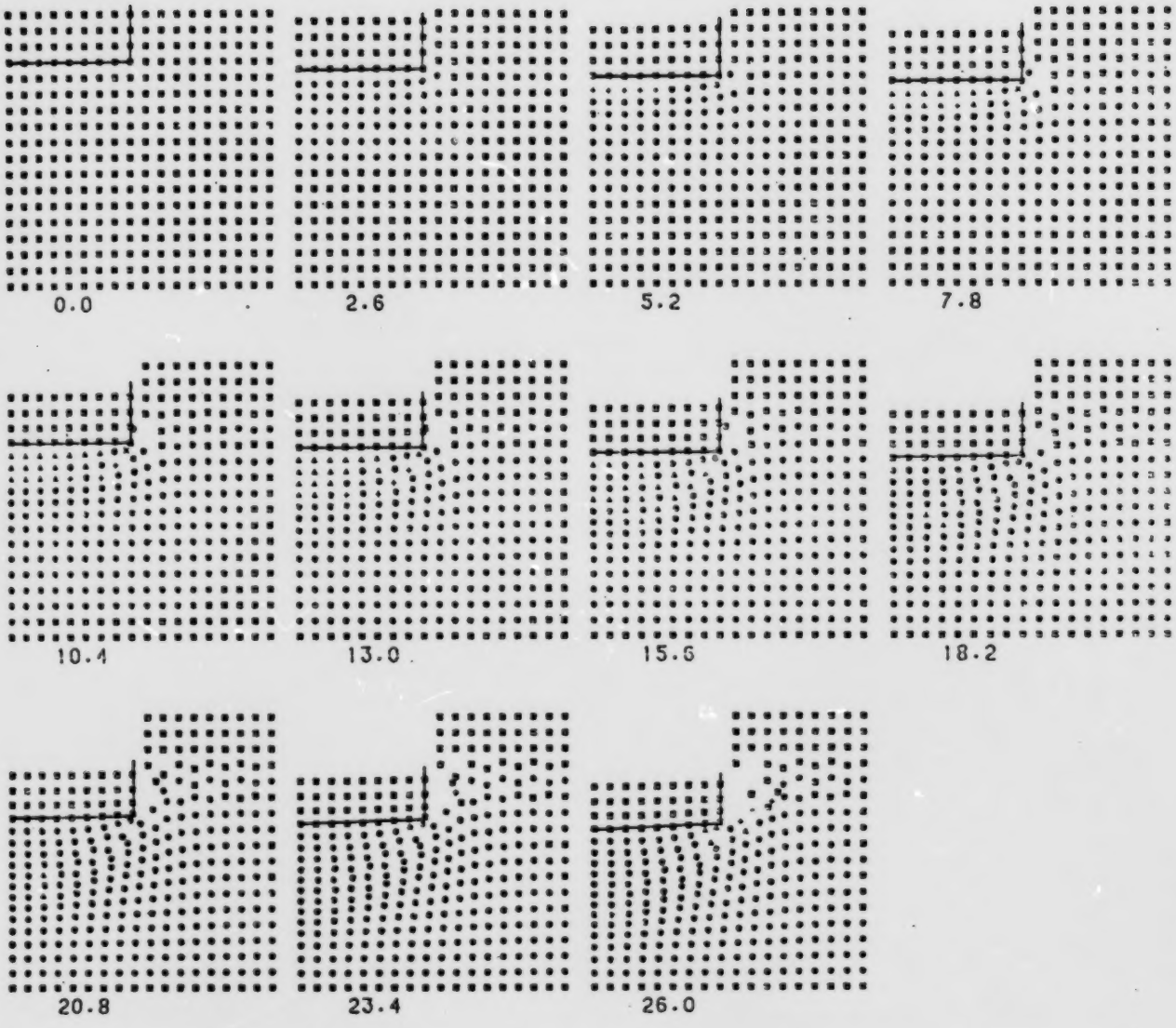

FIGURE 31A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 29)

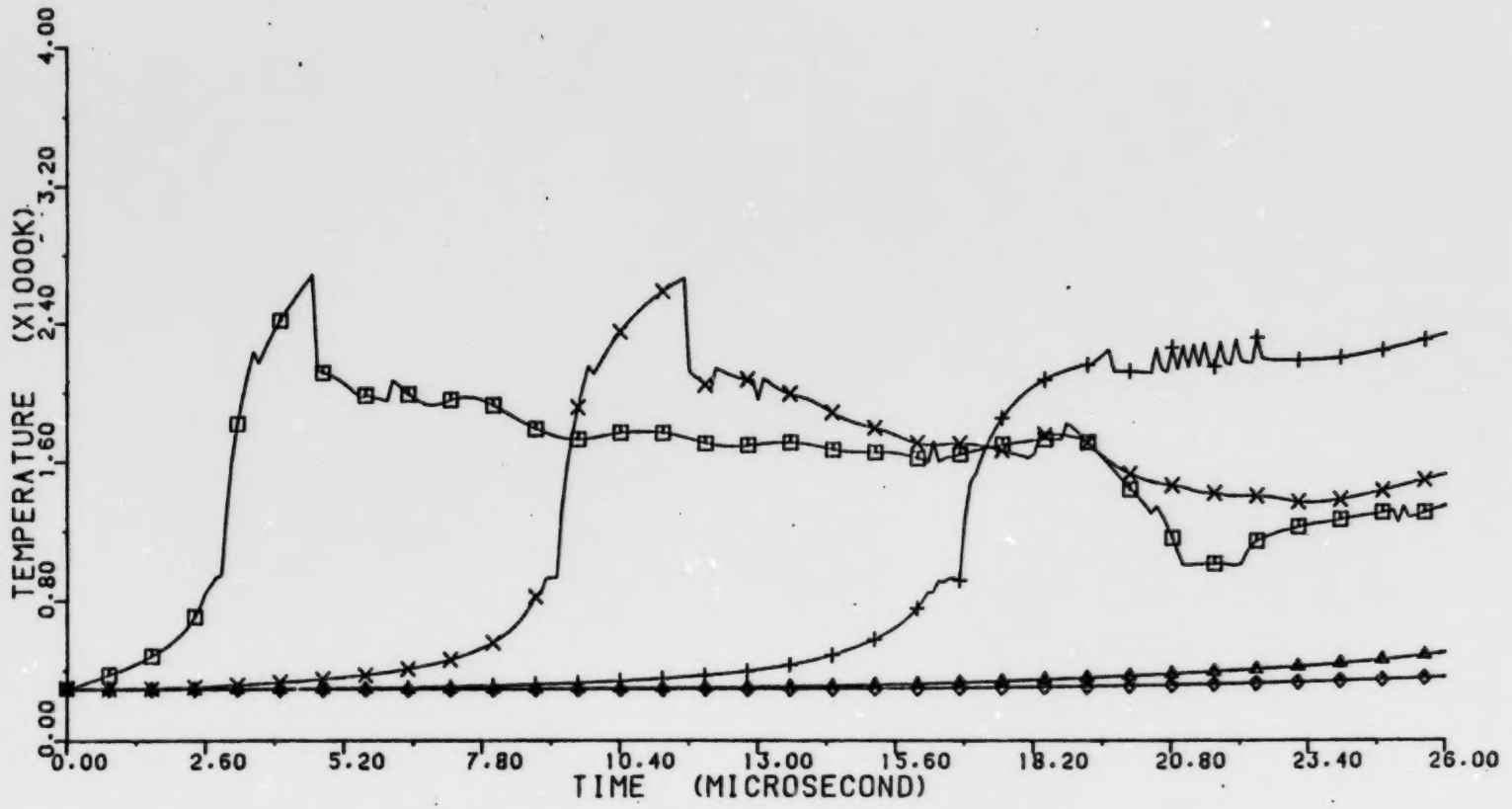

FIGURE 31B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 29)

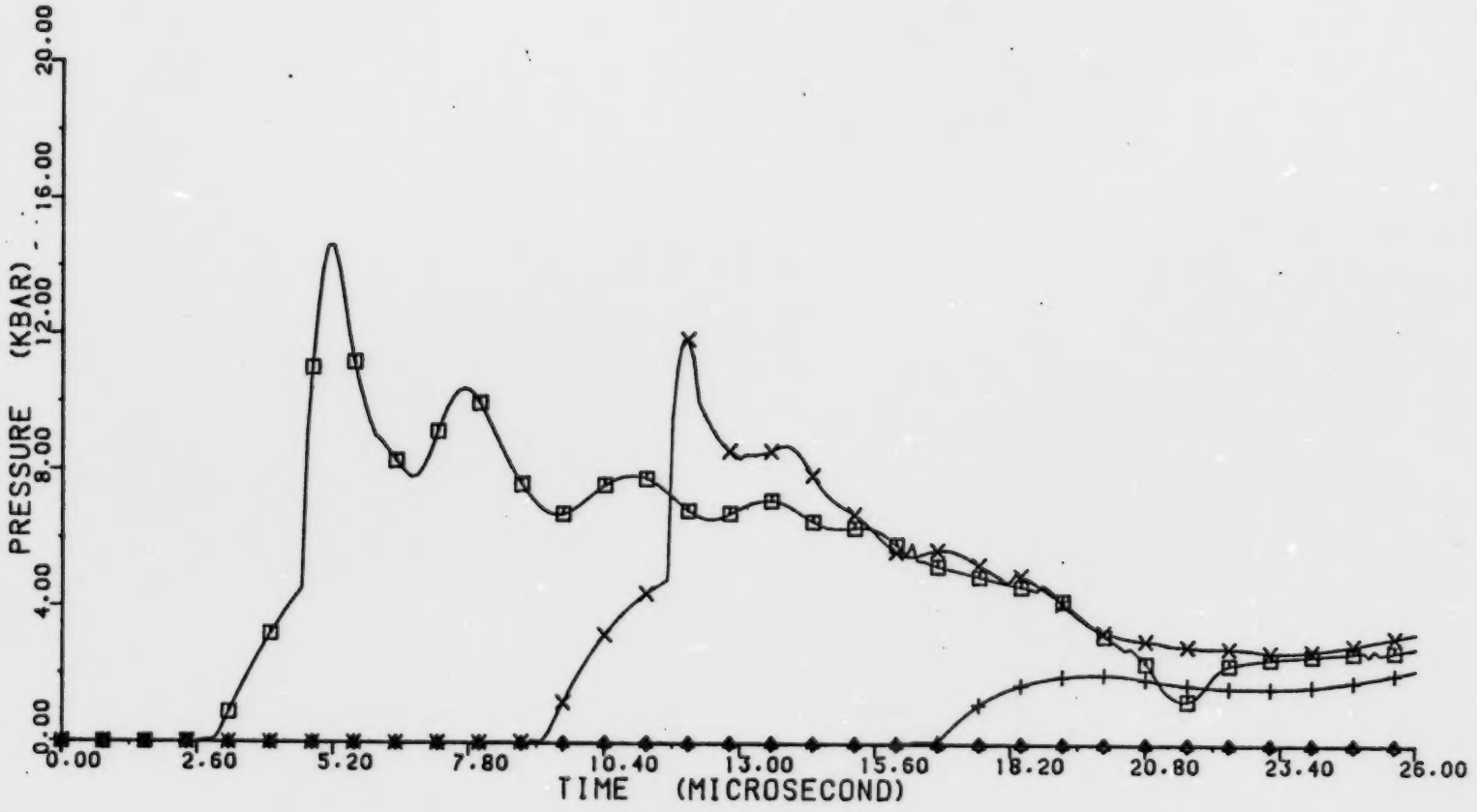

FIGURE 31C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 29)

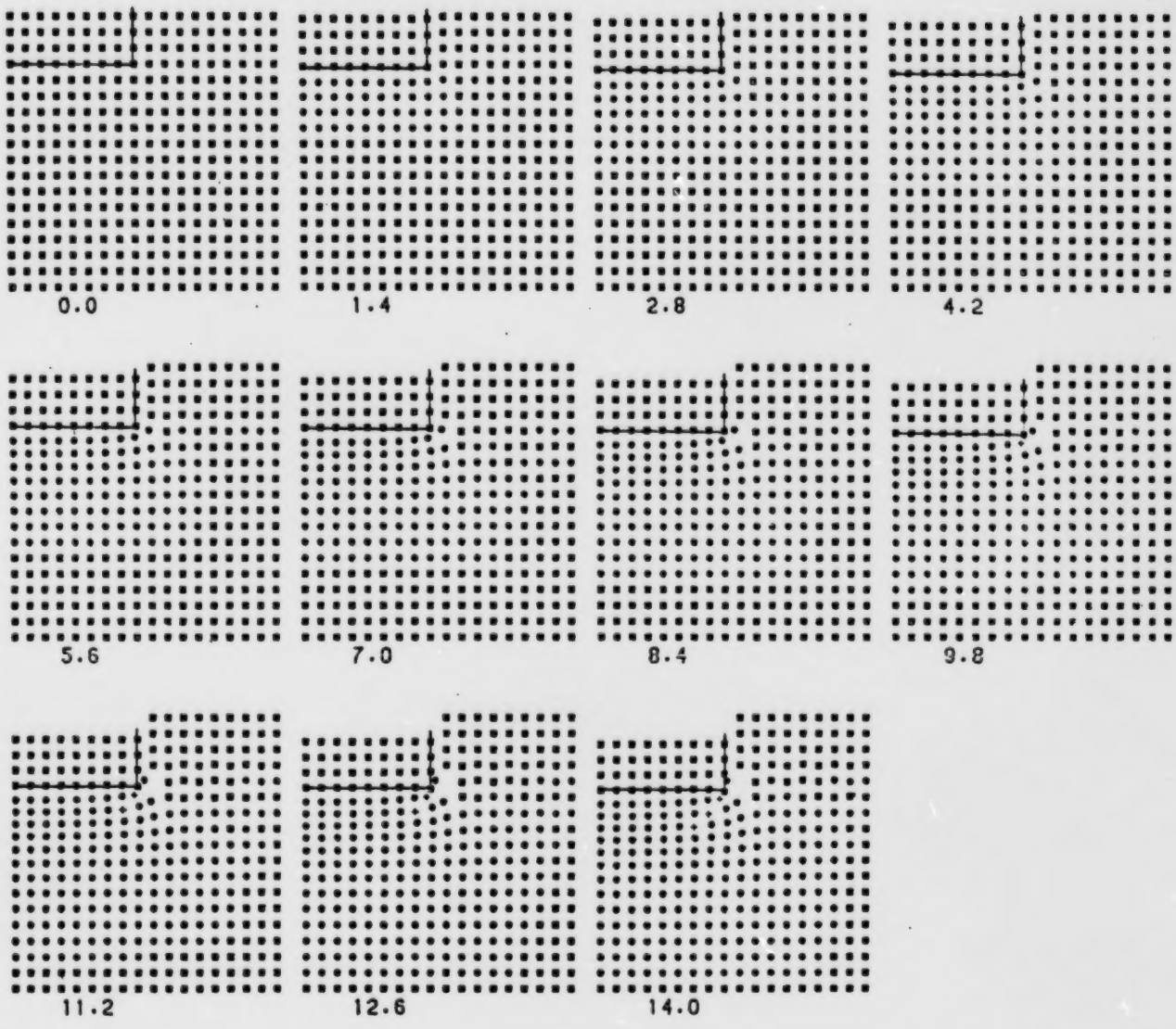

FIGURE 32A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 30)

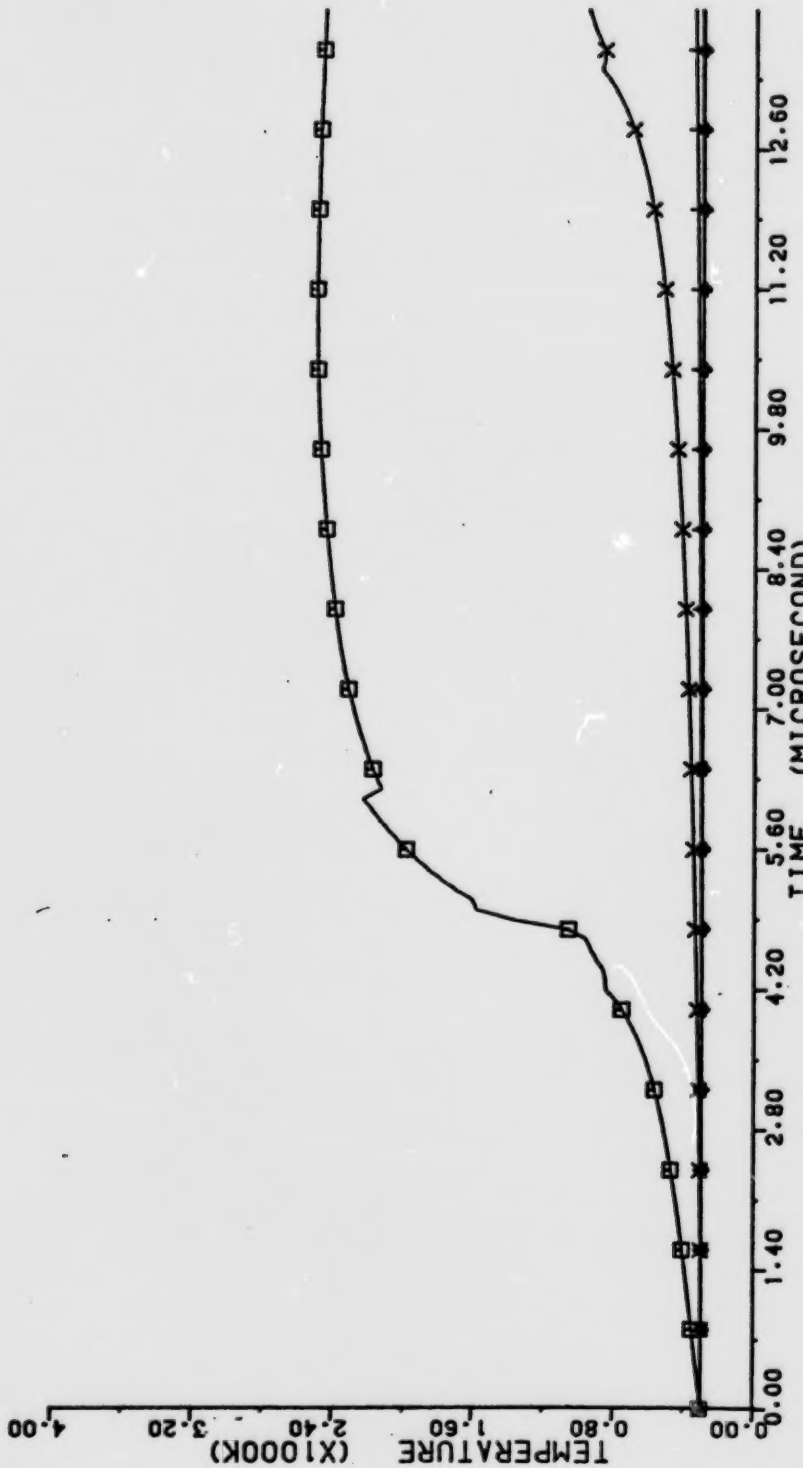

FIGURE 32B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 30)

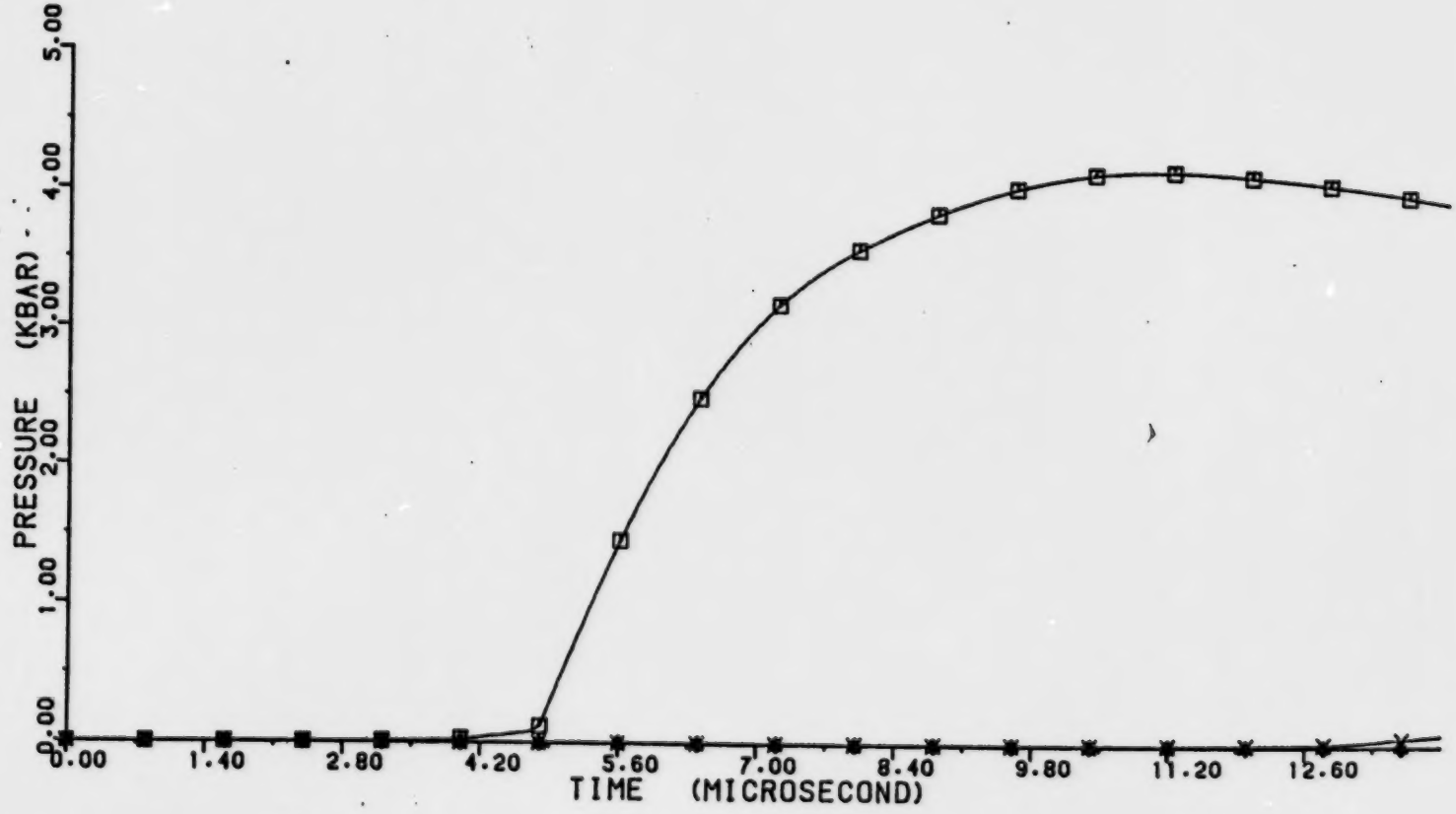

FIGURE 32C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 30)

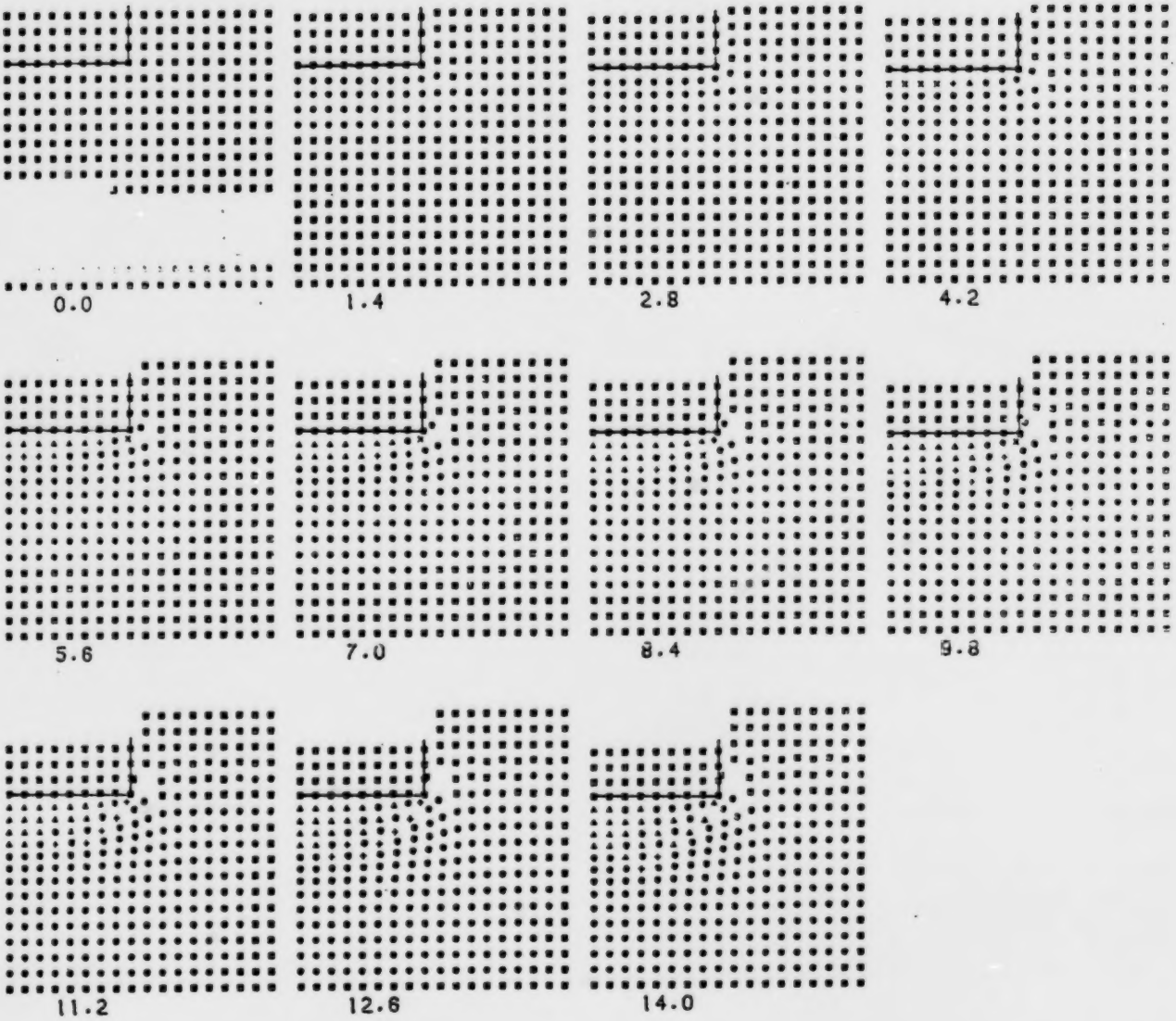

FIGURE 33A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 31)

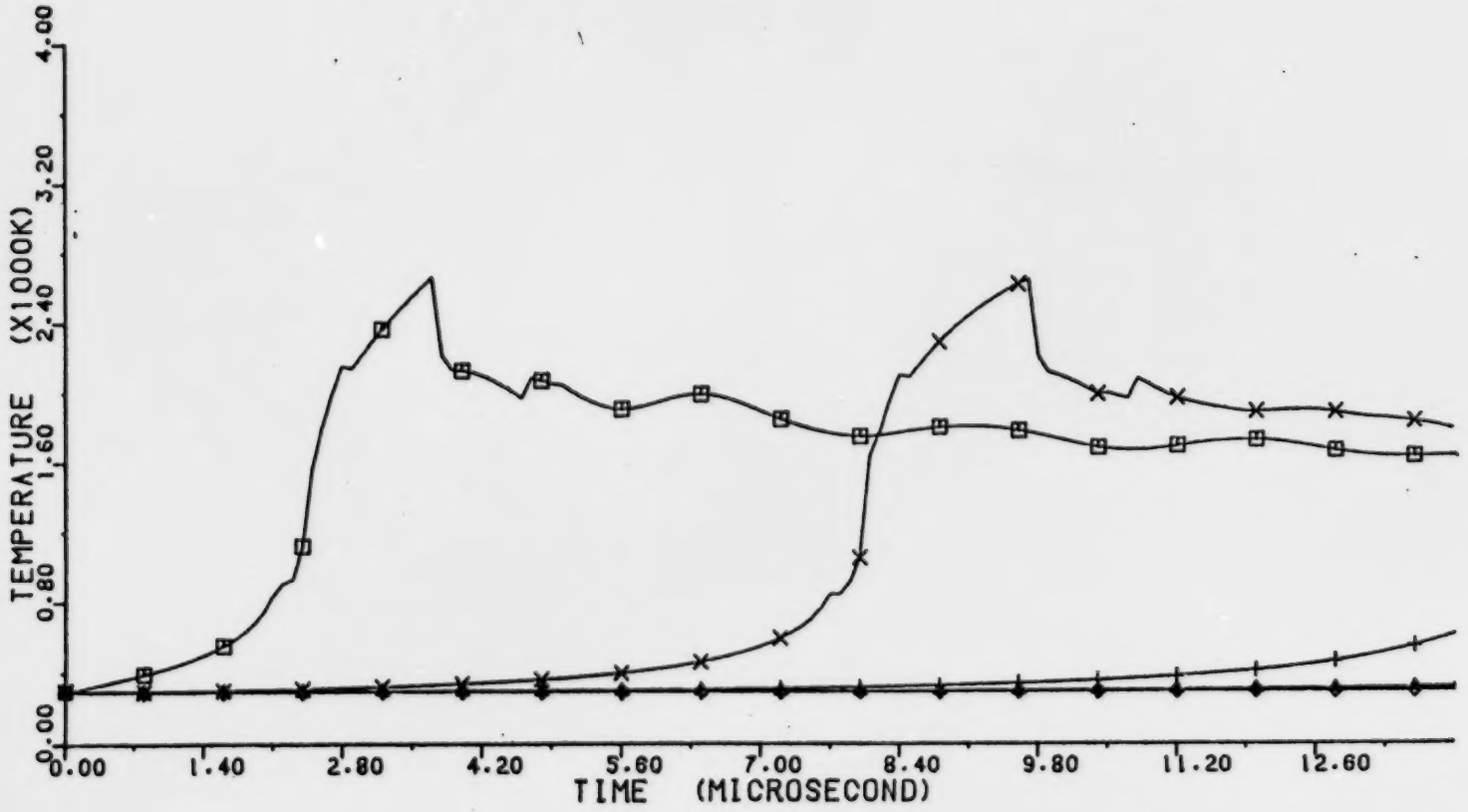

FIGURE 33B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 31)

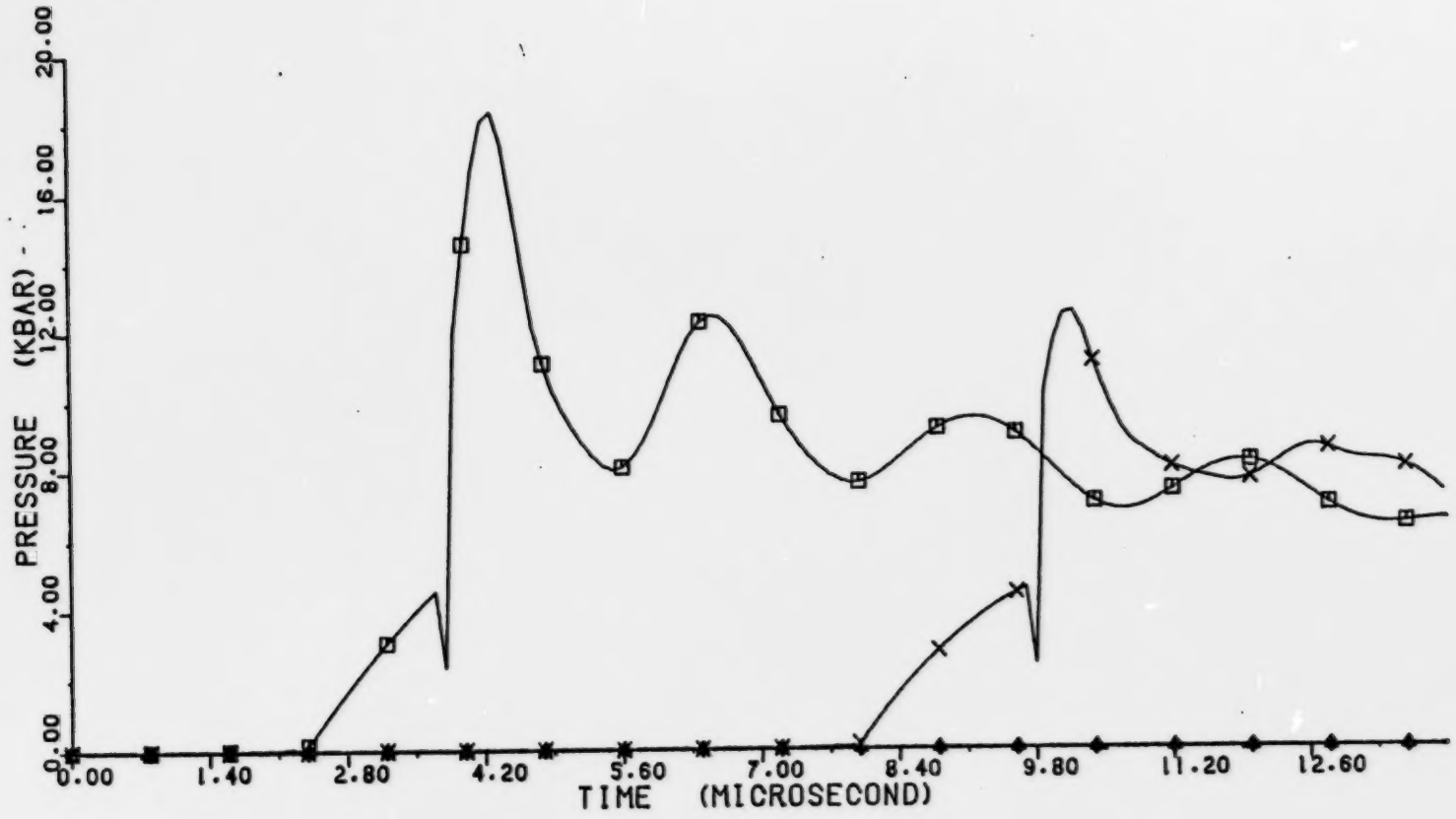

FIGURE 33C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 31)

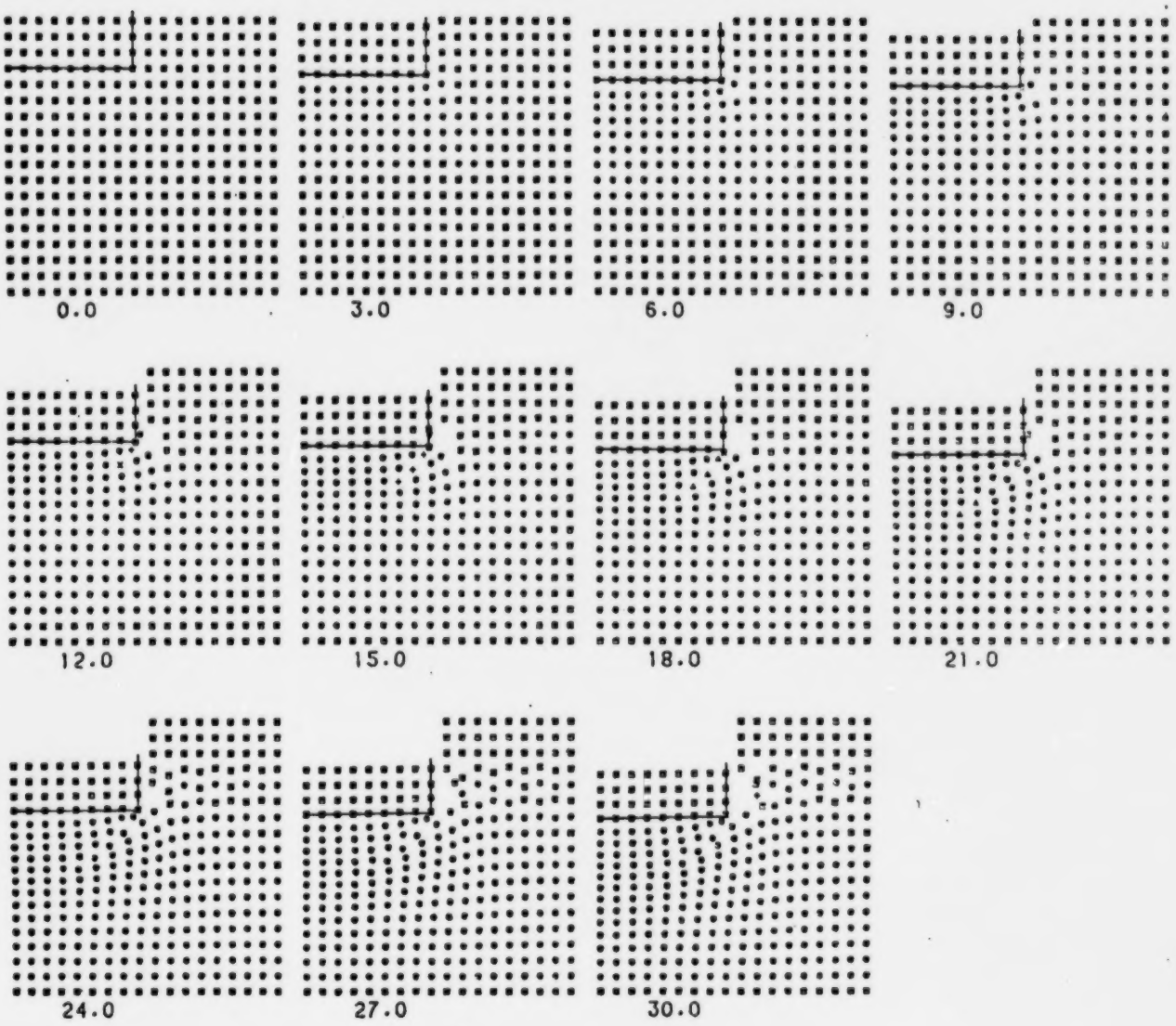

FIGURE 34A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 32)

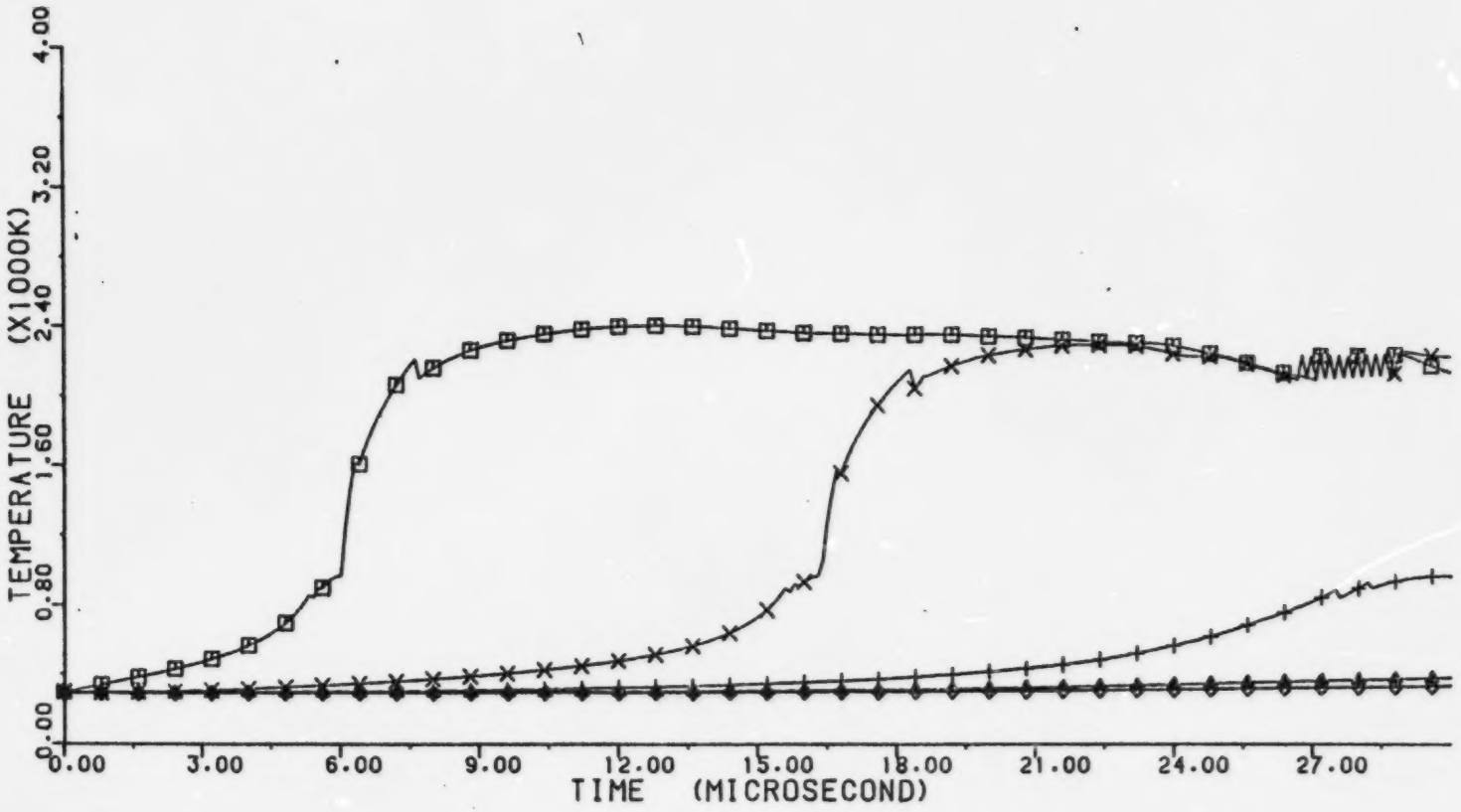

FIGURE 34B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 32)

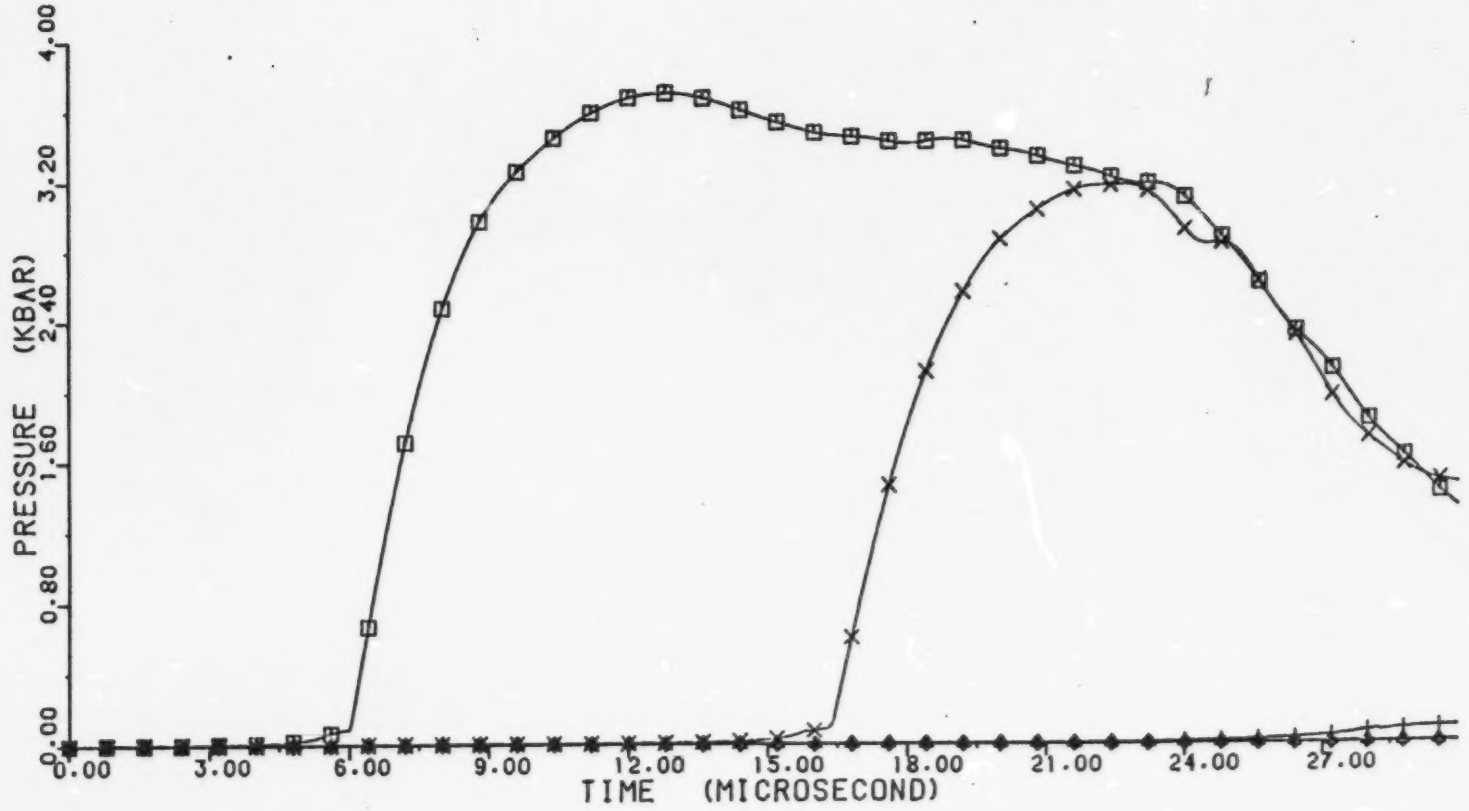

FIGURE 34C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 32)

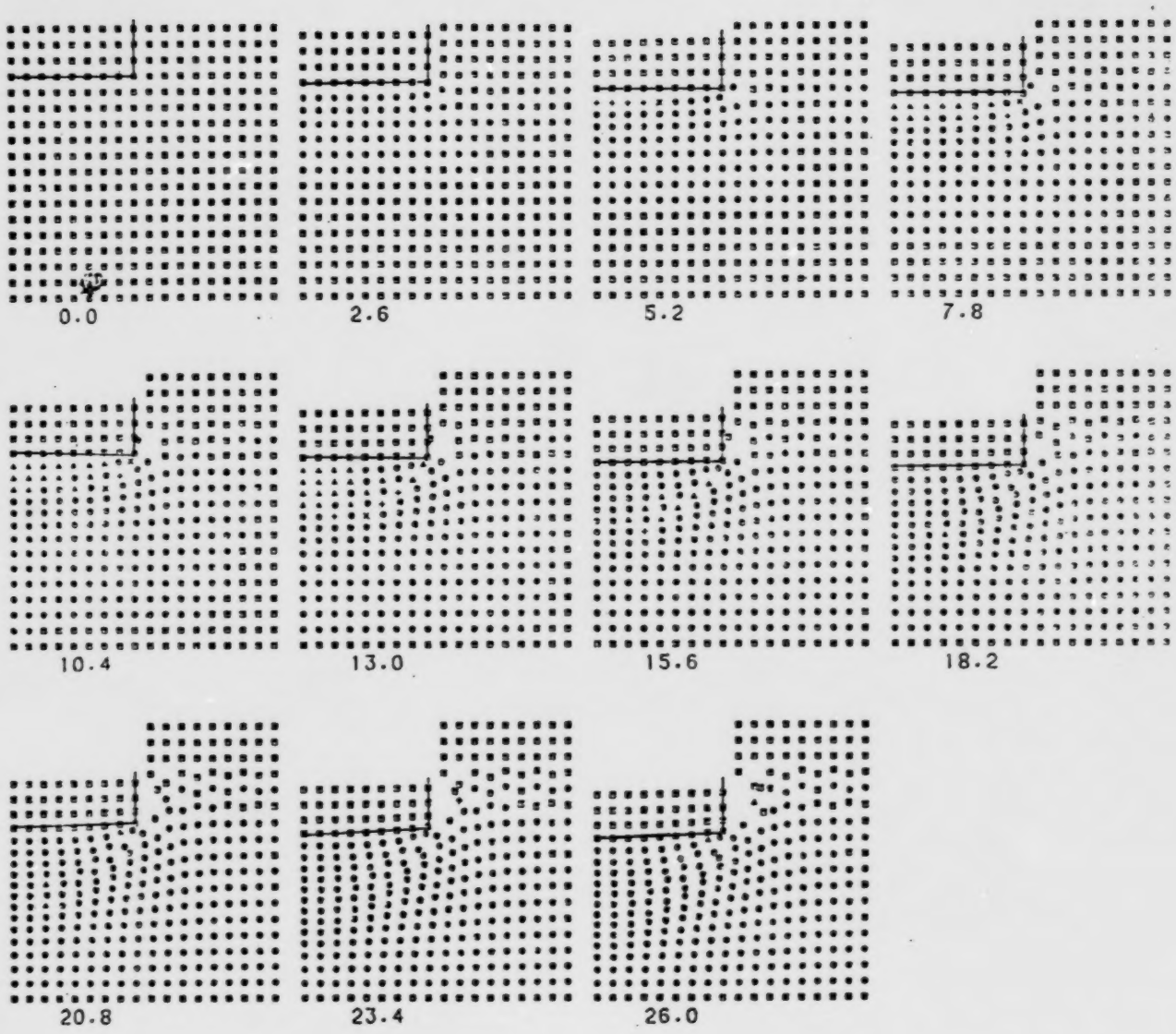

FIGURE 35A PROFILE OF DEFORMATION AND PRESSURE AS A FUNCTION OF TIME IN MICROSECOND (CASE 33)

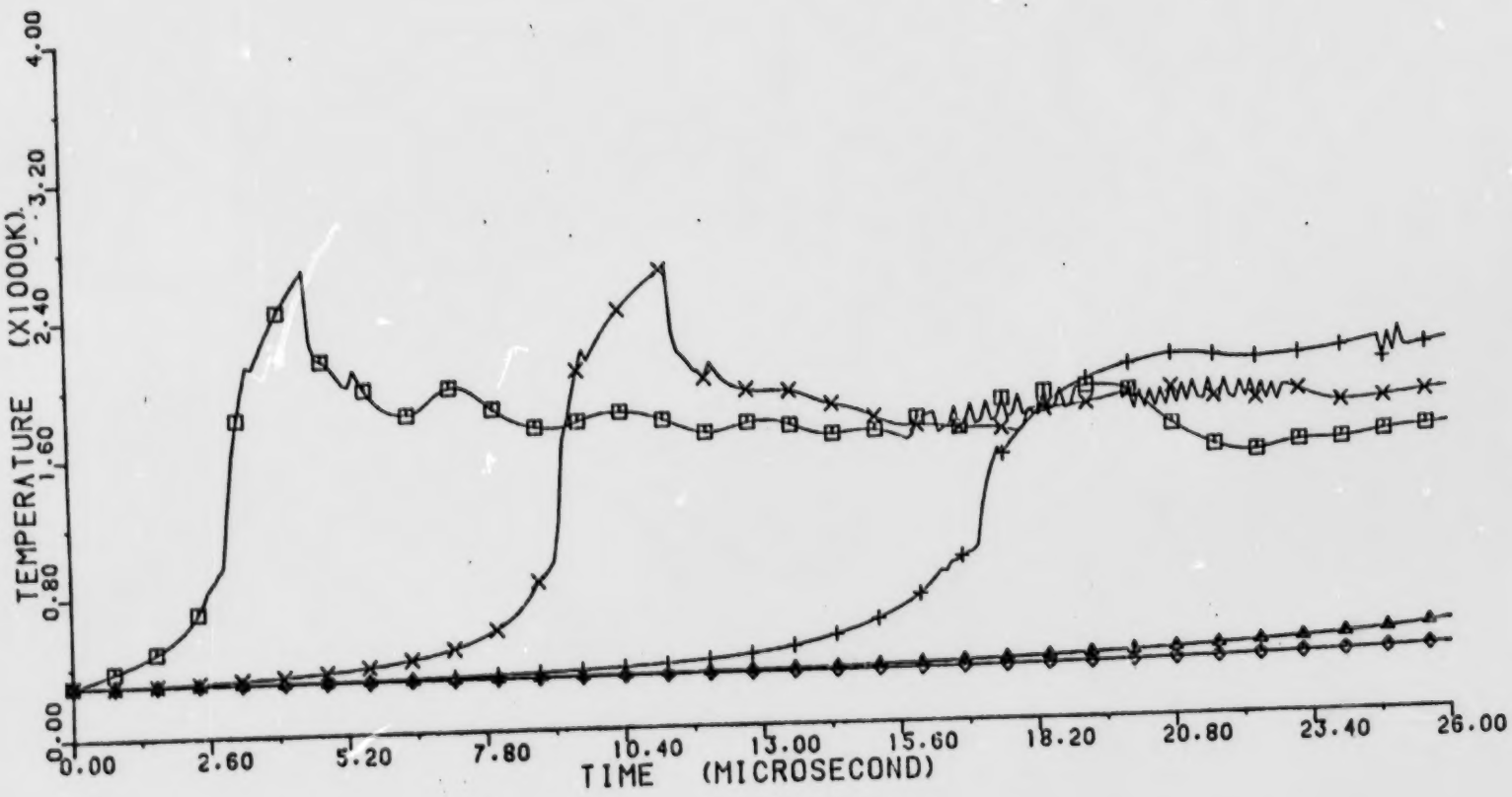

FIGURE 35B TEMPERATURE-TIME CURVES FOR FIVE MESH ZONES (CASE 33)

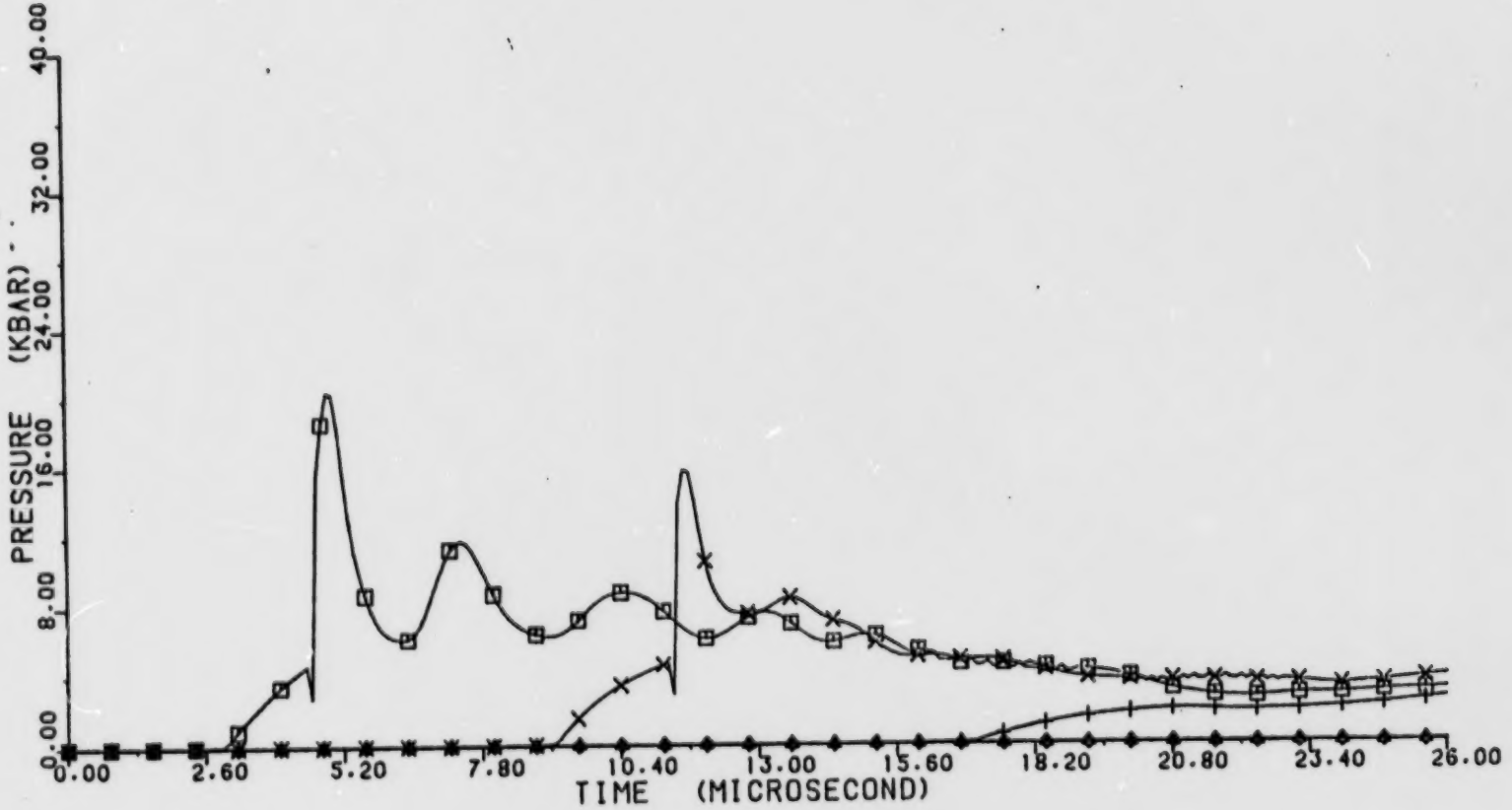

FIGURE 35C PRESSURE-TIME CURVES FOR FIVE MESH ZONES (CASE 33)

APPENDIX C

COMPUTER PROGRAM AND SUBROUTINES

(pp. 122-170)

```
      DIMENSION CDR(20,20),CDZ(20,20),DSR(20,20),DSZ(20,20),U(20,20),    EXP00010
     *V(20,20),P(20,20),Q(20,20),QR(20,20),QZ(20,20),QRZ(20,20),        EXP00020
     *GK(20,20) ,GL(20,20),GM(20,20),VOL(20,20),PTAPE(5),NAME(5)        EXP00030
      DIMENSION TEM(20,20)                                              EXP00040
      DIMENSION ENERGY(20,20)   ,UP(20,20),VP(20,20)                    EXP00050
      DIMENSION PPRE(20,20)                                             EXP00060
      DIMENSION PENER(20,20)                                            EXP00070
      DIMENSION PRCDE1(15),PRCDE2(15),PRCDE3(15),SOL(23),GAS(17)        EXP00080
     * ,XXL(20,20),XDL(20,20),XXA(20,20),XDA(20,20),XXS(20,20),         EXP00090
     * XDS(20,20),PS(20,20),EQ(7)                                       EXP00100
      DIMENSION WR(5000),WRT(5000)                                      EXP00110
      DIMENSION RAZ(10)                                                 EXP00120
      DIMENSION QKL(20,20),QDK(20,20),QDL(20,20)                        EXP00130
      DIMENSION TBURN(20,20)                                            EXP00140
       DIMENSION  SOSS(23)                                              EXP00150
      DIMENSION XMS(20,20), VNM1(20,20)                                 EXP00160
      DIMENSION Y1(1010),Y2(1010),Y3(1010),Y4(1010),Y5(1010),XXX(1010), EXP00170
     * X1(1010),X2(1010),X3(1010),X4(1010),X5(1010)                     EXP00180
       DIMENSION ANI(20,20),AN(20,20),CVG(20,20)                        EXP00190
      COMMON /PLTBUF/IBUF(1024)                                         EXP00200
      COMMON/PLT/NOK,NCL,NTA,KTA,DT,PMX,PMXX,KPB,KPE,KPS, LPB,LPE,LPS   EXP00210
     *,PLTIT(15)                                                        EXP00220
      COMMON/PV/XA,XL,XS,DA,DL,DS,CA,CL,CS,GA,GL,GS,PB,PE,PD,RAT,IPHASE,EXP00230
     * IP                                                               EXP00240
C     RGAS IN KCAL/MOLE-DEG K                                           EXP00250
      IIII = 1                                                          EXP00260
       SOLW = .033                                                      EXP00270
      IIPLOT =  1                                                       EXP00280
      RGAS = 0.00198717                                                 EXP00290
      READ(5,995) (PLTIT(I),I=1,15)                                     EXP00300
  995 FORMAT(15A1)                                                      EXP00310
      WRITE(6, 100)                                                     EXP00320
      READ(5,54) (NAME(I),I=1,5),C1,C2,C3,C4,C5                         EXP00330
      WRITE(6,55)(NAME(I),I=1,5),C1,C2,C3,C4,C5                         EXP00340
   54 FORMAT(5A4,6F10.0)                                                EXP00350
   55 FORMAT(1H0,6X,4HNAME,15X,11X,4H C1 ,11X,4H C2 ,11X,4H C3 ,11X,4H C EXP00360
     *4  ,11X,4H C5 /1X,5A4  ,10X,5E15.7)                               EXP00370
      READ(5,8110) IPHASE,IP,PB,PE,PD,RAT                               EXP00380
 8110 FORMAT(2I5,4F10.0)                                                EXP00390
      WRITE(6,1)                                                        EXP00400
    1 FORMAT(1H ,'IPHASE',3X,'IP',6X,'PB',13X,'PE',13X,'PD',13X,'RAT')  EXP00410
      WRITE(6, 8210) IPHASE,IP,PB,PE,PD,RAT                             EXP00420
 8210 FORMAT(1H ,2I5,4E15.7)                                            EXP00430
      READ(5, 8100) XA,DA,CA,GA                                         EXP00440
      XA = 0.1                                                          EXP00450
      XA = 0.0001                                                       EXP00460
      XA = .15                                                          EXP00470
      XA = 0.025                                                        EXP00480
      XA = 0.3                                                          EXP00490
      XA = 0.2                                                          EXP00500
      XA = 0.20                                                         EXP00510
      WRITE(6,2)                                                        EXP00520
    2 FORMAT(1H ,7X,'XA',13X,'DA',13X,'CA',13X,'GA')                    EXP00530
      WRITE(6,8300) XA,DA,CA,GA                                         EXP00540
      WRITE(6,3)                                                        EXP00550
    3 FORMAT(1H ,7X,'XL',13X,'DL',13X,'CL',13X,'GL')                    EXP00560
      READ(5, 8100) XL,DL,CL,GL                                         EXP00570
      XL = (1.-XA)/8.0*7.0                                              EXP00580
      XL = (1.-XA)/5.0*4.0                                              EXP00590
      IF (IPHASE .EQ. 2) XL = 0.0                                       EXP00600
            DL = 1.344                                                  EXP00610
             CL = 242300.                                               EXP00620
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```
                    GL = 2.91
      WRITE(6,8300) XL,DL,CL,GL                                         EXP00560
      READ(5,8100) XS,DS,CS,GS                                          EXP00570
       SG = 1.018                                                       EXP00580
      SG = 1.00000                                                      EXP00590
      XS = (1.-XA)+1.0/8.0                                              EXP00600
      XS =(1.-XA)*1./5.                                                 EXP00610
      IF (IPHASE .EQ. 2) XS = (1. - XA)
         DS = 1.128
           CS = 164700.
            GS = 2.17
      WRITE(6,4)                                                        EXP00620
    4 FORMAT(1H ,7X,'XS',13X,'DS',13X,'CS',13X,'GS')                    EXP00630
      WRITE(6,8300) XS,DS,CS,GS                                         EXP00640
 8100 FORMAT(8F10.0)                                                    EXP00650
 8300 FORMAT(1H ,6E15.7)                                                EXP00660
      READ(5,56) PJL,PJW,PJD,VINT                                       EXP00670
      VINT = -50000.                                                    EXP00680
      VINT = -10000.                                                    EXP00690
      VINT = -40000.                                                    EXP00700
      WRITE(6,57) PJL,PJW,PJD,VINT                                      EXP00710
   56 FORMAT(3F10.0)                                                    EXP00720
   57 FORMAT(1H0,6X,4H PJL,11X,4H PJW,11X,4H PJD,11X,4HVINT/1X,4E15.7)  EXP00730
      READ(5,50) NOT, NOK,NOL,DT,DRK,DZL,MDISP                          EXP00740
      WRITE(6,51) NOT,NOK,NOL,DT,DRK,DZL,MDISP                          EXP00750
   50 FORMAT(3I5,3F10.0,I5)                                             EXP00760
   51 FORMAT(1H0,6X,3HNOT,12X,3HNOK,12X,3HNOL,12X,3H DT,12X,3HDRK,12X,  EXP00770
     + 3HDZL,12X,3HMDISP/1X,3(I10,5X),3E15.7,I10)                       EXP00780
      READ(5,52)  KTS,KOUTS,KOUTE,KSP,LOUTS,LOUTE,LSP                   EXP00790
      WRITE(6,53) KTS,KOUTS,KOUTE,KSP,LOUTS,LOUTE,LSP                   EXP00800
   52 FORMAT(10I5)                                                      EXP00810
   53 FORMAT(1H0,5X,6H KTS   ,9X,6HKOUTS ,9X,6HKOUTE ,9X,6H KSP   ,9X,  EXP00820
     $6HLOUTS ,9X,6HLOUTE ,9X,6H LSP  /1X,7(I9,6X))                     EXP00830
      READ(5,64)  NPL,NGRA,CENM,YORIG,SORX,SORY                         EXP00840
      WRITE(6,65) NPL,NGRA,CENM,YORIG,SORX,SORY                         EXP00850
   64 FORMAT(2I5,4F10.0)                                                EXP00860
   65 FORMAT(1H0,5X,6H NPL   ,9X,6H NGRA ,11X,5H CENM,10X,5HYORIG,11X,  EXP00870
     +4HSORX,11X,4HSORY/1X,2(I9,6X),4E15.7)                             EXP00880
      READ(5,52)  KTA,KPB,KPE,KPS,LPB,LPE,LPS                           EXP00890
      WRITE(6,62) KTA,KPB,KPE,KPS,LPB,LPE,LPS                           EXP00900
   62 FORMAT(1H0,5X,6H KTA   ,9X,6H KPB   ,9X,6H KPE   ,9X,6H KPS   ,9X,  EXP00910
     $6H LPB   ,9X,6H LPE   ,9X,6H LPS   /1X,7(I9,6X))                  EXP00920
      READ(5,52)  KP1,LP1,KP2,LP2,KP3,LP3,KP4,LP4,KP5,LP5               EXP00930
      WRITE(6,66) KP1,LP1,KP2,LP2,KP3,LP3,KP4,LP4,KP5,LP5               EXP00940
   66 FORMAT(1H0,6X,3HKP1,5H  LP1,6X,10H  KP2  LP2,6X,10H  KP3  LP3,    EXP00950
     $ 6X,10H  KP4  LP4,6X,10H  KP5  LP5  /5X,5(2I5,6X))                EXP00960
      READ(5,8100) TINIT, PINIT                                         EXP00970
      PINIT = 1.0E+06                                                   EXP00980
      TINIT = 248.15                                                    EXP00990
      TINIT = 263.15                                                    EXP01000
      TINIT = 278.15                                                    EXP01010
      TINIT = 308.15                                                    EXP01020
      TINIT = 293.15                                                    EXP01030
      READ(5,8100) E,Z,H,CD,XMW                                         EXP01040
      Z = 4.0*1.0E+08                                                   EXP01050
        E = 53600.
         XMW = 61.042
      WRITE(6,6767) TINIT, PINIT,E,Z,H,CD,XMW                           EXP01060
      READ(5, 8100) RXZDV                                               EXP01070
        RXZDV = 0.6463
      READ(5, 8100) DSMAX                                               EXP01080
      READ(5, 8110) NCOMP                                               EXP01090
```

```
                                                                        EXP01110
                                                                        EXP01120
                                                                        EXP01130
                                                                        EXP01140
                                                                        EXP01150
                                                                        EXP01160
                                                                        EXP01180
                                                                        EXP01190
                                                                        EXP01200
                                                                        EXP01210
                                                                        EXP01220
                                                                        EXP01230
                                                                        EXP01240
                                                                        EXP01250
                                                                        EXP01260
                                                                        EXP01270
                                                                        EXP01280
                                                                        EXP01290
```

```
      DAC = DA
      CD = CD * 1.037/2.27.0
      DDA = DA
      DDL = DL
      DDS = DS
      AMIDP = 4.0E+07
        TMIN = 1000.
      ND = 5
      NOT = NS - 1
      IF(IPHASE .EQ. 2) GO TO 6400
      CALL PHASE3(D,ETA,PA,C)
      GO TO 6500
 6400 CALL PHASE2(D,ETA,PA,C)
 6500 CONTINUE
  100 FORMAT(1H1)
  103 FORMAT(1H1,///,1X)
  104 FORMAT(1H0)
  105 FORMAT(///)
C
C     COMPUTATION OF INITIAL VALUES
      NKI = NCK - 1
      NPJL = PJL/DZL + 0.01
      NCL = NCL + NPJL
      NL1 = NCL - 1
      NK2 = NK1 - 1
      NL2 = NL1 - 1
      NOT = 0.5+DT
      DDT = DT
      GHOT = HOT
      [illegible] = XA*DA + XL*DL + XS*DS
      NCT(.1/DT)/1000000 LESS THAN 140 OR EQUAL TO MULTIPLE OF 140 ONLY
      NCT = NOT*((.1001/DT)/1000000)
      NNS = 400
      NNK = (.1001/DT)/1000000
      KIS = KIS*(.1001/DT)/1000000
      [illegible] = [illegible]/100
        AKIA = KIA
      IF ( NCT .GT. 140)  KIA= NCT/140
      KIA = 0
      [illegible] = 1.0
C     [illegible] VARIABLE IS TIME IN MICROSECOND
C     [illegible] PLOTTED ON THE LINE PRINTER
      LLLLLL = 10
      NDATA = (NCT/KIA + 1)
      IF ( NCT .GT. 200) NODATA = 201
      XA(1) = 0.0
      XP(1) = 0.0
      DO [illegible] LLLLL = 1, 9
      [illegible] = LLLLL*NDATA
      [illegible](1+[illegible]) = 0.0
      [illegible](1+[illegible]) = 300.
 [illegible] CONTINUE
      KIA = KIA + 1
      KPJA = PJL/DX + 2.5
      WRITE(6, 6000) KPJA , NPJL
 6000 FORMAT(///10H KPJA=    ,I5,10H  NPJL=    ,I10)
      KPJA1 = KPJA + 1
      [illegible] = [illegible]/V1.1
      PMA = -10000.
      KMA = 0
      LMA = 0
      [illegible] = 0
```

```
      NGR = 0                                                           EXP01870
      TIM = 0.0                                                         EXP01880
      DX = DRK                                                          EXP01890
      IF ( DRK .GT. DZL) DX = DZL                                       EXP01900
C                                                                       EXP01910
C                                                                       EXP01920
C     MODEL S T UP                                                      EXP01930
      UPNKL = 0.0                                                       EXP01940
      VONKL = 0.0                                                       EXP01950
      DO 110 L = 1, NGL                                                 EXP01960
      DO 100 K = 1, NGK                                                 EXP01970
C     TEMP. AT TIME = (N-1)DT          ,UP(K,L)                         EXP01980
C     TEMP. AT TIME = NDT    ,TEM(K,L)                                  EXP01990
C     TEMP. AT TIME = (N+1)DT     ,TIT                                  EXP02000
      TEM(K,L) = TINIT                                                  EXP02010
      THURN(K,L) = 0.0                                                  EXP02020
      UP(K,L) = TINIT                                                   EXP02030
      PS(K,L) = PINIT*1.0E-06                                           EXP02040
      CO2(K,L) = DZL*(L-2)                                              EXP02050
      CO4(K,L) = DRK*(K-2)                                              EXP02060
C     IF (L .NE. NGL .OR. K .GT. KPJW) GO TO 107                        EXP02070
C     CO2(K,L) = CO2(K,L-1)+PJL                                         EXP02080
  107 CONTINUE                                                          EXP02090
      P(K,L) = 0.0                                                      EXP02100
      Q(K,L) = 0.0                                                      EXP02110
      QR(K,L) = 0.0                                                     EXP02120
      QZ(K,L) = 0.0                                                     EXP02130
      QRZ(K,L) = 0.0                                                    EXP02140
      U(K,L) = 0.0                                                      EXP02150
      V(K,L) = 0.0                                                      EXP02160
      DSR(K,L) = 0.0                                                    EXP02170
      DSZ(K,L) = 0.0                                                    EXP02180
      QK(K,L) = 0.0                                                     EXP02190
      QL(K,L) = 0.0                                                     EXP02200
      QKL(K,L) = 0.0
      QDK(K,L) = 0.0
      QDL(K,L) = 0.0
      PPR (K,L) = 0.0                                                   EXP02210
      ENERGY(K,L) = 0.0                                                 EXP02220
      ENERGY(K,L) = 23.98/DDA                                           EXP02230
      PS(K,L) = 0.0                                                     EXP02240
      IF ( K .GT. KPJW .OR. L .LT. NL1) GO TO 106                       EXP02250
      IF (K .GT. KPJW .OR. L .LT. (NL1-NPJL)) GO TO 106
      V(K,L) = VINT                                                     EXP02260
  106 CONTINUE                                                          EXP02270
      VNL(K,L) = 0.0                                                    EXP02280
      EM(K,L) = 0.0                                                     EXP02290
  105 CONTINUE                                                          EXP02300
  110 CONTINUE                                                          EXP02310
C                                                                       EXP02320
C                                                                       EXP02330
      DO 120 L = 2, NGL                                                 EXP02340
      DO 110 K = 2, NGK                                                 EXP02350
      R1 = CO4(K,L)                                                     EXP02360
      R2 = CO4(K-1,L)                                                   EXP02370
      R3 = CO4(K-1,L-1)                                                 EXP02380
      R4 = CO4(K,L-1)                                                   EXP02390
      Z1 = CO2(K,L)                                                     EXP02400
      Z2 = CO2(K-1,L)                                                   EXP02410
      Z3 = CO2(K-1,L-1)                                                 EXP02420
      Z4 = CO2(K,L-1)                                                   EXP02430
      VNL(K,L) = VOLUME(R1,R2,R3,R4,Z1,Z2,Z3,Z4)                        EXP02440
```

```
      VOL1(K,L) = VOL(K,L)
      IF ( L . [illegible] L .AND. K .LE. KPJW) SM(K,L) = PJD*VOL(K,L)    EXP02450
      IF( [illegible] .( [illegible] ) .AND. K.LE. KPJW) GO TO 911          EXP02460
      GO TO [illegible]
  911 CONTINUE
      [illegible](K,L) = PJ[illegible]VOL(K,L)
      ADA(K,L) = 0.0
      ADL(K,L)= 0.0
      ADS(K,L) = 0.0
      AXA(K,L) = 0.0
      AXL(K,L) = 0.0
      XA (K,L) = 1.0
      GO TO 115
  912 CONTINUE
      IF ( L .[illegible]. ( L-NPJL) .AND. K .GT. KPJW) GO TO 913
      GO TO [illegible]
  913 CONTINUE
      [illegible](K,L) = 0.0[illegible] VOL(K,L)
      ADA(K,L) = 0.0001
      ADL(K,L) = 0.0
      ADS(K,L) = 0.0
      XAA(K,L) = 1.0
      AAL(K,L) = 0.0
      XAS(K,L) = 0.0
      GO TO 115
  914 CONTINUE
      IF ( L . [illegible] L) GO TO 115
      [illegible](K,L) = VOL(K,L)[illegible]NSK                        EXP02470
      A[illegible](K,L) = A[illegible]VOL(K,L)                          EXP02480
      A[illegible](K,L) = 1. /(0.[illegible]0.21*S[illegible].)*VOL(K,L)*XA*DA  EXP02490
      [illegible](K,L) = A[illegible](K,L)                              EXP02500
      AAL(K,L) = AL                                                     EXP02510
      AAS(K,L) = XS                                                     EXP02520
      AAA(K,L) = A[illegible]                                           EXP02530
      [illegible](K,L) = DA                                             EXP02540
      ADL(K,L) = DL                                                     EXP02550
      [illegible](K,L) = DS                                             EXP02560
  115 CONTINUE                                                          EXP02570
  1[illegible] CONTINUE                                                 EXP02580
      IF ( [illegible] .[illegible]. [illegible]) GO TO 7001            EXP02590
      IF([illegible] [illegible]) GO TO 2310                            EXP02600
      CALL [illegible]( [illegible], 7.0)                               EXP02610
      [illegible] = 1./[illegible]                                      EXP02620
      CALL [illegible]([illegible])                                     EXP02630
      CALL [illegible](3.0,Y[illegible]1.,-3)                           EXP02640
  [illegible] CONTINUE                                                  EXP02650
      [illegible] = 0                                                   EXP02660
      GO TO 7000                                                        EXP02670
 7001 [illegible] 1                                                     EXP02680
      IF( [illegible] .LT. [illegible]) WRITE(6,5000) NCK,NCL,KPJW,XA,AL,XS,VINT,DT,  EXP02690
     [illegible]                                                        EXP02700
      IF( [illegible] .LT. [illegible]) WRITE (6,5001) ((CCR(KK,LL),KK=1,NCK),LL=1,NCL  EXP02710
     [illegible]).((([illegible](KK,LL),KK=1,NCK),LL=1,NCL)            EXP02720
 5000 FORMAT(2H [illegible] 1[illegible]12.5)                           EXP02730
 5001 FORMAT(1H [illegible]11.4)                                        EXP02740
      Y1(1) = .0                                                        EXP02750
      Y2(1) = .0                                                        EXP02760
      Y3(1) = .0                                                        EXP02770
      Y4(1) = .0                                                        EXP02780
      [illegible](1) = .0                                               EXP02790
      [illegible](1) = 0.                                               EXP02800
      [illegible](1) = 0.0                                              EXP02810
```

```
                                                                        EXP02930
                                                                        EXP02940
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                                                                        EXP02970
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                                                                        EXP02990
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                                                                        EXP03380
```

```
      QC = Q(K+1,L+1)                                                   EXP03390
      QD = Q(K,L+1)                                                     EXP03400
      QRA = QR(K,L)                                                     EXP03410
      QRB = QR(K+1,L)                                                   EXP03420
      QRC = QR(K+1,L+1)                                                 EXP03430
      QRD = QR(K,L+1)                                                   EXP03440
      QZA = QZ(K,L)                                                     EXP03450
      QZB = QZ(K+1,L)                                                   EXP03460
      QZC = QZ(K+1,L+1)                                                 EXP03470
      QZD = QZ(K,L+1)                                                   EXP03480
      QRZA = QRZ(K,L)                                                   EXP03490
      QRZB = QRZ(K+1,L)                                                 EXP03500
      QRZC = QRZ(K+1,L+1)                                               EXP03510
      QRZD = QRZ(K,L+1)                                                 EXP03520
      QKA = QK(K,L)                                                     EXP03530
      QKB = QK(K+1,L)                                                   EXP03540
      QKC = QK(K+1,L+1)                                                 EXP03550
      QKD = QK(K,L+1)                                                   EXP03560
      QLA = QL(K,L)                                                     EXP03570
      QLB = QL(K+1,L)                                                   EXP03580
      QLC = QL(K+1,L+1)                                                 EXP03590
      QLD = QL(K,L+1)                                                   EXP03600
      QKLA = QKL(K,L)
      QKLB = QKL(K+1,L)
      QKLC = QKL(K+1,L+1)
      QKLD = QKL(K,L+1)
      QDKA = QDK(K,L)
      QDKB = QDK(K+1,L)
      QDKC = QDK(K+1,L+1)
      QDKD = QDK(K,L+1)
      QDLA = QDL(K,L)
      QDLB = QDL(K+1,L)
      QDLC = QDL(K+1,L+1)
      QDLD = QDL(K,L+1)
      VA = VLUME(R1,R2,R3,R4,Z1,Z2,Z3,Z4)                               EXP03610
      VB = VLUME(R6,R1,R4,R5,Z3,Z1,Z4,Z5)                               EXP03620
      VC = VLUME(R7,R8,R1,R6,Z7,Z8,Z1,Z6)                               EXP03630
      VD = VLUME(R8,R9,R2,R1,Z8,Z9,Z2,Z1)                               EXP03640
      SSCD = QRZC - QRZD                                                EXP03650
     * + QKLC - QKLD
      SSCB = QRZC - QRZB                                                EXP03660
     * + QKLC - QKLB
      SSBA = QRZB - QRZA                                                EXP03670
     * + QKLB - QKLA
      SSDA = QRZD - QRZA                                                EXP03680
     * + QKLD - QKLA
      RCJC = [illegible]+1.ANIJ(R7,R6,R1,R8,Z7,Z6,Z1,Z8)/VC             EXP03690
      RCJD = [illegible]+1.ANIJ(R8,R9,R2,R1,Z8,Z9,Z2,Z1)/VD             EXP03700
      RCJB = [illegible]+1.ANIJ(R6,R1,R4,R5,Z6,Z1,Z4,Z5)/VB             EXP03710
      RCJA = [illegible]+1.ANIJ(R1,R2,R3,R4,Z1,Z2,Z3,Z4)/VA             EXP03720
  210 CONTINUE                                                          EXP03730
      RCJ[illegible] = (RCJC+RCJD)*0.5                                  EXP03740
      RCJ[illegible] = (RCJC+RCJB)*0.5                                  EXP03750
      RCJ14 = (RCJB+RCJA)*0.5                                           EXP03760
      RCJ1[illegible] = (RCJD+RCJA)*0.5                                 EXP03770
      IF (ABS(RCJ31) .LE. 0.000000001) GO TO 222                        EXP03780
      [illegible] = -1.0*((QC+QC+QKC-QRC-P)-QD-QKD+QRD)*(Z8-Z1)+SSCD+(R8-R1))/ EXP03790
     * RCJ31                                                            EXP03800
     * = (QDKC - QDKD)*(Z8-Z1)/RCJ31
      V[illegible]1 = ((QC+QZC+QRC+QZC+[illegible]+QKD+QZD)*(R8-R1)+SSCD+(Z8-Z1))/RCJ31   EXP03810
     * +(QDKC - QDKD)*(R8 - R1)/RCJ31
      [illegible]                                                       EXP03820
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[illegible] UD[illegible] = 0.0                                                    EXP03330
      VD[illegible] = 0.0                                                    EXP03840
[illegible] IF ( ABS(R[illegible]) .LE. 0.00000001) GO TO 224                    EXP03850
      UD[illegible] = ((PD+QD-QLD-QRD-PA-QA+QLA+QRA)*(Z6-Z1)+SSCB*(R6-R1))/RCJ61 EXP03860
     * + (QDLC - QDLB)*(Z6 - Z1)/RCJ61
      VD[illegible] = -1.0*((PD+QD-QLD-QZD-PA-QA-QLA+QZA)*(R6-R1)+SSCB*(Z6-Z1))/  EXP03870
     * RCJ61                                                                EXP03880
     * - (QDLC - QDLB)*(R6 - R1)/RCJ61
      GO TO 225                                                              EXP03890
[illegible] UD[illegible] = 0.0                                                    EXP03900
      VD[illegible] = 0.0                                                    EXP03910
[illegible] IF ( ABS(R[illegible]) .LE. 0.00000001) GO TO 226                    EXP03920
      UD14 = -1.0*((PD+QD-QKD-QRD-PA-QA+QKA+QRA)*(Z1-Z4)+SSBA*(R1-R4))/  EXP03930
     * RCJ14                                                                EXP03940
     * - (QDKD - QDKA)*(Z1 - Z4)/RCJ14
      VD14 = ((PD+QD-QKD-QZD-PA-QA+QKA+QZA)*(R1-R4)+SSBA*(Z1-Z4))/RCJ14  EXP03950
     * + (QDKD - QDKA)*(R1 - R4)/RCJ14
      GO TO 227                                                              EXP03960
[illegible] UD14 = 0.0                                                    EXP03970
      VD14 = 0.0                                                             EXP03980
[illegible] IF ( ABS(RCJ12) .LE. 0.00000001) GO TO 228                    EXP03990
      UD12 = ((PD+QD-QLD-QRD-PA-QA+QLA+QRA)*(Z1-Z2)+SSDA*(R1-R2))/RCJ12  EXP04000
     * + (QDLD - QDLA)*(Z1 - Z2)/RCJ12
      VD12 = -1.0*((PD+QD-QLD-QZD-PA-QA+QLA+QZA)*(R1-R2)+SSDA*(Z1-Z2))/  EXP04010
     * RCJ12                                                                EXP04020
     * + (QDLD - QDLA)*(R1 - R2)/RCJ12
      GO TO 229                                                              EXP04030
[illegible] UD12 = 0.0                                                    EXP04040
      VD12 = 0.0                                                             EXP04050
[illegible] CONTINUE                                                         EXP04060
      IF ( ABS(DMA) .LE. 0.00000001) GO TO 232                               EXP04070
      TJM = TRANJ(R1,R2,R3,R4,Z1,Z2,Z3,Z4)/DMA                               EXP04080
      UDA = TJM*(2.0*QRA+QZA)                                                EXP04090
     *+TJM*(2.0*QKA + QLA)
      VDA = TJM*QKZA                                                         EXP04100
     *+TJM*QKLA
      GO TO 233                                                              EXP04110
[illegible] UDA = 0.0                                                     EXP04120
      VDA = 0.0                                                              EXP04130
[illegible] IF ( ABS(DMB) .LE. 0.00000001) GO TO 234                      EXP04140
     *TJM = TRANJ(R5,R1,R4,R5,Z6,Z1,Z4,Z5)/DMB                               EXP04150
      UDB = TJM*(2.0*QRB+QZB)                                                EXP04160
     *+TJM*(2.0*QKB + QLB)
      VDB = TJM*QKZB                                                         EXP04170
     *+TJM*QKLB
      GO TO 236                                                              EXP04180
[illegible] UDB = 0.0                                                     EXP04190
      VDB = 0.0                                                              EXP04200
[illegible] IF ( ABS(DMC) .LE. 0.00000001) GO TO 237                      EXP04210
      TJM = TRANJ(R7,R8,R1,R6,Z7,Z8,Z1,Z6)/DMC                               EXP04220
      UDC = TJM*(2.0*QRC+QZC)                                                EXP04230
     *+TJM*(2.0*QKC + QLC)
      VDC = TJM*QKZC                                                         EXP04240
     *+TJM*QKLC
      GO TO 238                                                              EXP04250
[illegible] UDC = 0.0                                                     EXP04260
      VDC = 0.0                                                              EXP04270
[illegible] IF ( ABS(DMD) .LE. 0.00000001) GO TO 239                      EXP04280
      TJM = TRANJ(R8,R9,R2,R1,Z8,Z9,Z2,Z1)/DMD                               EXP04290
      UDD = TJM*(2.0*QRD+QZD)                                                EXP04300
     *+TJM*(2.0*QKD + QLD)
      VDD = TJM*QKZD                                                         EXP04310
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      [illegible]                                                                  EXP04320
      [illegible]                                                                  EXP04330
      [illegible] = 0.0                                                            EXP04340
      [illegible] = 0.0                                                            EXP04350
  242 CONTINUE                                                                     EXP04360
      R01 = 0.25*(2.0*(R3-R1)+R7-R6+R9-R2)                                         EXP04370
      Z01 = 0.25*(2.0*(Z3-Z1)+Z7-Z6+Z9-Z2)                                         EXP04380
      R14 = 0.25*(2.0*(R1-R4)+R6-R5+R2-R3)                                         EXP04390
      Z14 = 0.25*(2.0*(Z1-Z4)+Z6-Z5+Z2-Z3)                                         EXP04400
      R61 = 0.25*(2.0*(R6-R1)+R7-R8+R5-R4)                                         EXP04410
      Z61 = 0.25*(2.0*(Z6-Z1)+Z7-Z8+Z5-Z4)                                         EXP04420
      R12 = 0.25*(2.0*(R1-R2)+R8-R9+R4-R3)                                         EXP04430
      Z12 = 0.25*(2.0*(Z1-Z2)+Z6-Z9+Z4-Z3)                                         EXP04440
      Y61 = (R61*(R61+R12)+Z61*(Z61+Z12))/((R61+R12)**2+(Z61+Z12)**2)              EXP04450
      Y81 = (R81*(R81+R14)+Z81*(Z81+Z14))/((R81+R14)**2+(Z81+Z14)**2)              EXP04460
      UDNKL=Y81*Y81*(UDA-UDB+UDC-UDD)+Y81*(UD14-UD81+UDB-UDC)                      EXP04470
      [illegible]+Y81*(UD12-UD61+UDD-UDC)+UD61+UD81+UDC                            EXP04480
      VDNKL=Y81*Y81*(VDA-VDB+VDC-VDD)+Y81*(VD14-VD81+VDB-VDC)                      EXP04490
      [illegible]+Y81*(VD12-VD61+VDD-VDC)+VD81+VD61+VDC                            EXP04500
      IF ( N .NE. 1) GO TO 171                                                     EXP04510
      U(K,L) = U(K,L) + 0.5*DT*UDNKL                                               EXP04520
      V(K,L) = V(K,L)+0.5*DT*VDNKL                                                 EXP04530
      GO TO 500                                                                    EXP04540
  171 U(K,L) = U(K,L)+DT*UDNKL                                                     EXP04550
      V(K,L) = V(K,L)+DT*VDNKL                                                     EXP04560
      [illegible] V IS AT N+1/2
      IF ((UDNKL .LT. -1.0 .AND. IIII .LE. 100) .OR.
     *(V(K,L) .GE. 100. .AND. IIII .LE. 100))
     *(U(K,L) .LT. -10.0 .AND. IIII .LE. 100))
     [illegible] R1,Z1,R2,Z2,R3,Z3,R4,
     [illegible] R7,Z7,R8,Z8,R9,Z9,PA,PB,PC,PD,QMA,QMB,QMC,QMD,QA,
     [illegible] QZA,QZB,QZC,QZD,QRZA,QRZB,QRZC,QRZD,
     [illegible] VA,VB,VC,VD,SSCD,SSCB,SSBA,SSDA,
     [illegible] ROJ14,ROJ12,UD81,VD81,
     [illegible] ROJ81,ROJ61,ROJ14,ROJ12,UD81,VD81,
     [illegible] UDA,UDB,VDB,UDC,VDC,UDD,
     [illegible] VD12,IJM,JDA,VDA,VDB,VDC,VDD,
     [illegible] Y61,Y81,UDNKL,VDNKL,
     [illegible] Z14,R61,Z61,R12,Z12,Y61,Y81,UDNKL,VDNKL,
     [illegible] QDLA,QDLB,QDLC,QDLD
     [illegible] QDKA,QDKB,QDKC,QDKD,QDLA,QDLB,QDLC,QDLD
     [illegible] (IH .12X,8I13.5/))
     [illegible] IIII .LE. 100) .OR.
     IF ((UDNKL .LT. -1.0 .AND. IIII .LE. 100) .OR.
     *(V(K,L) .GE. 100. .AND. IIII .LE. 100))
     *(U(K,L) .LT. -10.0 .AND. IIII .LE. 100))
     IIII = IIII + 1                                                             EXP04570
  500 CONTINUE                                                                   EXP04580
  600 CONTINUE                                                                   EXP04590
      BOUNDARY CONDITION AT K=2 **** SLIDE ***                                   EXP04600
      DO 174 L=1, NEL                                                            EXP04610
      V(3,L) = 0.5*(V(2,L)+V(3,L))                                               EXP04620
      V(2,L) = V(3,L)                                                            EXP04630
      V(1,L) = V(3,L)                                                            EXP04640
      V(1,L) = -V(3,L)                                                           EXP04650
      U(3,L) = 0.0                                                               EXP04660
      [illegible] AT K = NOK - 1   *** SIDE ***                                  EXP04670
      [illegible] (NOL-NPOL)) GO TO 512                                          EXP04680
      [illegible] = 0.0
      [illegible] = 0.0
      [illegible]
      [illegible] = 0.0
      [illegible] = 0.0
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      DO 7717 K = 2, NOK
         U(K,L) = 0.0
 7717 CONTINUE
  174 CONTINUE                                                          EXP04690
      NOLL = NOL - NOUL
      NOLL1 = NOLL - 1
C     BOUNDARY CONDITION AT L=2 **** SLIDE ***                          EXP04700
      DO 175 K = 1, NOK                                                 EXP04710
      U(K,L) = 0.0                                                      EXP04720
      V(K,L) = 0.0                                                      EXP04730
      IF ( K .GT.KPJ.1) GO TO 177
C     IF ( K .GT. KPJA) GO TO 177                                       EXP04740
C       BOUNDARY CONDITION FOR ABOVE THE BULLET
      V(K,NOL) = V(K,NL1)
      U(K,NOL) = U(K,NL1)
      GO TO 175
C     V(K,NL1) = V(K,NL1)                                               EXP04750
C     U(K,NL1) = 0.0                                                    EXP04760
  177 CONTINUE                                                          EXP04770
      BOUNDARY CONDITION FOR TOP OF CHARGE
C     V(K,NOL) = V(K,NL1)                                               EXP04780
C     U(K,NOL) = U(K,NL1)                                               EXP04790
      V(K,NOLL) = V(K,NOLL1)
      U(K,NOLL) = U(K,NOLL1)
         U(K,NOLL) = 0.0
         U(K,NOLL1) = 0.0
  175 CONTINUE                                                          EXP04800
C                                                                       EXP04810
C     COMPUTATION OF DISPLACEMENT AND STRESS                            EXP04820
      DO 180 K = 3, NK1                                                 EXP04830
      DO 180 L = 3, NL1                                                 EXP04840
      RA = R(K,L)                                                       EXP04850
      QA = Q(K,L)                                                       EXP04860
      QRA = QR(K,L)                                                     EXP04870
      QZA = QZ(K,L)                                                     EXP04880
      VOLT1 =          VOLUME(COR(K,L),COR(K-1,L),COR(K-1,L-1),COR(K,L-1),EXP04890
     *COZ(K,L),COZ(K-1,L),COZ(K-1,L-1),COZ(K,L-1))                      EXP04900
      DENS = DM(K,L)/VOLT1                                              EXP04910
      U1 = U(K,L)                                                       EXP04920
      V1 = V(K,L)                                                       EXP04930
      U2 = U(K-1,L)                                                     EXP04940
      V2 = V(K-1,L)                                                     EXP04950
      U3 = U(K-1,L-1)                                                   EXP04960
      V3 = V(K-1,L-1)                                                   EXP04970
      IF (N .EQ. 180 .AND. L .EQ. 14 .AND. K.EQ. 9) WRITE(6,7707)
C     IIIII,VOLT1,DENS,U1,V1,U2,V2,U3,V3
      U4 = U(K,L-1)                                                     EXP04980
      V4 = V(K,L-1)                                                     EXP04990
      R1 = COR(K,L)+U1*HDT                                              EXP05000
      Z1 = COZ(K,L)+V1*HDT                                              EXP05010
      R2 = COR(K-1,L)+U2*HDT                                            EXP05020
      Z2 = COZ(K-1,L)+V2*HDT                                            EXP05030
      R3 = COR(K-1,L-1)+U3*HDT                                          EXP05040
      Z3 = COZ(K-1,L-1)+V3*HDT                                          EXP05050
      IF (N .EQ. 180 .AND. L .EQ. 14 .AND. K.EQ. 9) WRITE(6,7707)
C     IIIII2,U4,V4,R1,Z1,R2,Z2,R3,Z3
      R4 = COR(K,L-1)+U4*HDT                                            EXP05060
      Z4 = COZ(K,L-1)+V4*HDT                                            EXP05070
      VA = XXA(K,L)+VNM1(K,L)                                           EXP05080
      VL = XXL(K,L)+VNM1(K,L)                                           EXP05090
      VS = XXS(K,L)+VNM1(K,L)                                           EXP05100
      VN = VOLUME(R1,R2,R3,R4,Z1,Z2,Z3,Z4)                              EXP05110
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      RIJK = 1.0/((R1-R3)*(Z2-Z4)-(R2-R4)*(Z1-Z3))                      EXP05120
      RVZ = RIJK*((U1-U3)*(Z2-Z4)-(U2-U4)*(Z1-Z3))                      EXP05130
      IF (N .EQ. 150 .AND. L .EQ. 14 .AND. K.EQ. 3) WRITE(6,7707)
     1III,J,...,VA,VL,VS,VN,RIJK,...
      DUDZ = RIJK*((U2-U4)*(R1-R3)-(U1-U3)*(R2-R4))                     EXP05140
      DZZ = RIJK*((V2-V4)*(R1-R3)-(V1-V3)*(R2-R4))                      EXP05150
      DVDR = RIJK*((V1-V3)*(Z2-Z4)-(V2-V4)*(Z1-Z3))                     EXP05160
      TTD = (U1+U2+U3+U4)/(R1+R2+R3+R4)                                 EXP05170
      RVD = ...(DUDZ+DVDR)                                              EXP05180
      THTAD = RVD + TTD + DZZ                                           EXP05190
      ... = ... - THTAD/3.0                                             EXP05200
      ... = DZZ - THTAD/3.0                                             EXP05210
      TA = VOL(K,L)/VN - 1.0                                            EXP05220
      TTT = ...(K,L)
      IF (N .GE. 150 .AND. L .EQ. 14 .AND. K.EQ. 3) WRITE(6,7707)
     1III,DUDZ,DZZ,DVDR,TTD,THTAD,...,TA,TTT
      ... = 1.0
      IF (L .LE. (LI-IPJL) .AND. K .LE. KPJA) GO TO 9100
      IF (L .GT. (LI-IPJL) .AND. K .GT. KPJA) GO TO 180
      IF (IPHASE .EQ. 2) GO TO 6410                                     EXP05230
      CALL PHASE1(I,TA,PA,C)                                            EXP05240
      GO TO 6510                                                        EXP05250
 6410 CALL PHASE2(I,TA,PA,C)                                            EXP05260
 6510 CONTINUE                                                          EXP05270
      IF (PA .LE. 1.0) PA = 1.0
      V... = 0.0
      ...(1) = 0.0                                                      EXP05280
      ...(2) = 0.0                                                      EXP05290
      ...(3) = 1.0                                                      EXP05300
C                                                                       EXP05310
C     VL IS THE VOL. OF LIQUID IN THE GRID (K,L)                        EXP05320
C     VI IS THE VOL. OF GAS AFTER IMPACT FOR T = (N+1) DT               EXP05330
C     ... IS THE MASS OF GAS IN THE (K,L) AT T=(N+1)DT BEFORE BURNINGEXP05340
C     ... IS MASS FRACTION OF UNDECOMPOSED SLID AT T=(N+1)DT BEFORE BUREXP05350
      V... = XS*VOL(K,L)        *(GS*...*(PA-PO)/(DS*CS**2)+1.)**(-1./  EXP05360
     *...)                                                              EXP05370
      IF (IPHASE .EQ. 2) VSN = XS*VOL(K,L)*((PO*0....+GS+DS*CS*CS)
     */(...*GS+...*CS*CS))**(1./GS)
      IF(XS(K,L) .LE. 0.0) VSN = 0.0
      VLN = 0.0
      IF (IPHASE .EQ. 3)
      VLN = XL*VOL(K,L)        .(GL*...*(PA-PO)/(DL*CL**2)+1.)**(-1./   EXP05380
     *GL)                                                               EXP05390
      VVI = VN - VLN - VSN                                              EXP05400
      IF(VVI.LT.0.0) VLN = VN - VSN                                     EXP05410
      IF(VVI .LT. 0.0) VSN = VN - VLN
      ... = VA ...(K,L)                                                 EXP05420
      ... = ...TA                                                       EXP05430
      ... = ... ...(K,L)/...(K,L)                                       EXP05440
      ... = ...NIS
      IF (N .GE. 150 .AND. L .EQ. 15 .AND. K.EQ. 3) WRITE(6,7707)
     1III,...,VLN,VI,...TA,...NIS
      XAAI = VI/VN                                                      EXP05450
      ... = ...TA/VI/XOL(K,L)                                           EXP05460
      ... = 1./(...+1.)*XAAI-1.                                         EXP05470
      IF (N .GE. ... .AND. L .EQ. 15)                                   EXP05480
     * WRITE(6,...7) ...TA,...NIS,   ...TA,VL,VS,VI,VA                  EXP05490
      IF (N .GE. 3 .AND. L .EQ. 15)                                     EXP05500
     * WRITE (6, 6707)   V,...XA(K,L),VN,...(K,L),XXA(K,L),XXL(K,L),XXS(K,L) EXP05510
     *,...XAAA                                                          EXP05520
      IF (N .GE. 3 .AND. L .EQ. 15) WRITE(6, 6707) XXS(K,L),XOS(K,L)    EXP05530
     *,V...,...(K,L),...NIS,VOL(K,L),V...,VS                            EXP05540
      ... = XOS(K,L)                                                    EXP05550
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      XAA(K,L) = 1.0
      IF(VV1.LE. 0.0) XAA(K,L) =VV1/VN                                 EXP05560
      XAL(K,L) = VL /VN                                                EXP05570
      XAS(K,L) = VS /VN                                                EXP05580
      TAXA = XOA(K,L)                                                  EXP05590
      IF(VV1.LT. 0.0)) TAXA = XOA(K,L)*VA/VV1                          EXP05600
      XOA(K,L) = TAXA                                                  EXP05610
      XBL(K,L) = 0.0                                                   EXP05620
      IF (VLN .GT. 0.0)
     *XBL(K,L) = XOL(K,L)*VL/VLN
        IF(VSN .LE. 0.0000000001) XDS(K,L) = 0.0                       EXP05630
             IF (VSN .GT. 0.0000000001)
      XDS(K,L) = XDS(K,L)*VS/VSN
      IF (K .EQ. 5 .AND. L .LE. 15) WRITE(6, 868) THETA,XDA(K,L),XBL(K,LEXP05640
     *),XDS(K,L),K,L                                                   EXP05650
      VMAT(K,L) = VN                                                   EXP05660
      PA = (P3+P0)*1.E0                                                EXP05670
      IF (K .NE. 3) GO TO 300                                          EXP05680
      IF ( PA .LT. PMAX) GO TO 350                                     EXP05690
      PMAX = PA                                                        EXP05700
      KMAX = K                                                         EXP05710
      LMAX = L                                                         EXP05720
      [illegible]                                                      EXP05730
  350 CONTINUE                                                         EXP05740
      DVOL = [illegible]V(X1,X2,X3,X4,Z1,Z2,Z3,Z4,U1,U2,U3,U4,V1,V2,V3,V4,DT)  EXP05750
      DVOT = DVOL/[illegible]                                          EXP05760
      IF(DVOT .GT. 0.0) GO TO 310                                      EXP05770
      UM = (U1 +U2+U3+U4)*0.25                                         EXP05780
      DUA = 2.0*(ABS(U1-UM)+ABS(U2-UM)+ABS(U3-UM)+ABS(U4-UM))          EXP05790
      VM = (V1+V2+V3+V4)*0.25                                          EXP05800
      DVA = 2.0*(ABS(V1-VM)+ABS(V2-VM)+ABS(V3-VM) +ABS(V4-VM))         EXP05810
      [illegible]                                                      EXP05820
      [illegible]                                                      EXP05830
      [illegible]                                                      EXP05840
      [illegible]DVOT/VN                                               EXP05850
      GO TO 315                                                        EXP05860
  310 CONTINUE                                                         EXP05870
      [illegible] = 0.0
      [illegible] = 0.0                                                EXP05880
      [illegible] = 0.0                                                EXP05890
  315 [illegible]                                                      EXP05900
      [illegible]                                                      EXP05910
      IF (L .LE. (LL1-LPJL) .AND. K .LE. KPJK)                         EXP05920
      [illegible](1)/[illegible](13)[illegible]1.0
      [illegible]                                                      EXP05930
      [illegible]                                                      EXP05940
      [illegible]                                                      EXP05950
      [illegible]                                                      EXP05960
      [illegible]                                                      EXP05970
      [illegible]                                                      EXP05980
      [illegible]SIN +C[illegible]*2.0[illegible]SINT**2               EXP05990
      [illegible]                                                      EXP06000
      [illegible]                                                      EXP06010
      [illegible]                                                      EXP06020
      IF (L .LE. ([illegible]) .AND. K .LE. KPJK) GO TO 310            EXP06030
      [illegible] + P3(K,L)
      [illegible] + P3(K,L) *1.0E+12                                   EXP06040
      [illegible]                                                      EXP06050
      PA = PA + P3(K,L)                                                EXP06060
      PA = PA + P3(K,L) *1.0E+12                                       EXP06070
      [illegible]                                                      EXP06080
                                                                       EXP06090
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C     DERAV = [illegible] *1.0E-6                                                  EXP06100
C     DEZAV = [illegible]                                                          EXP06110
C     DEZAV = [illegible] *1.0E-6                                                  EXP06120
C     DERZAV = [illegible]                                                         EXP06130
C     DERZAV = [illegible] *1.0E-6                                                 EXP06140
C     DERAV = (QRA - QR(K,L))*1.0E-06                                              EXP06150
C     DEZAV = (QZA - QZ(K,L))*1.0E-06                                              EXP06160
C     DERZAV = (QRZA - QRZ(K,L))*1.0E-06                                           EXP06170
C     PAV = (P(K,L) + PA)/2.0*1.0E-6 + QA      *1.0E-6                             EXP06180
C     PAV = (P(K,L) + PA)/2.0          + QA                                        EXP06190
C     QRAV = (QR(K,L) + QRA)/2.0 + TEMP*ERD    /2.0                                EXP06200
C     QZAV = (QZ(K,L) + QZA)/2.0 + TEMP*EZD        /2.0                            EXP06210
C     QRZAV = (QRZ(K,L) + QRZA)/2.0 + TEMP*ERZD /2.0                               EXP06220
C     PAV = (P(K,L) + PA)/2.0 + QA*1.0E-06                                         EXP06230
C     QRAV = (QR(K,L) + QRA)/2.0 + TEMP*ERD                                        EXP06240
C     QZAV = (QZ(K,L) + QZA)/2.0 + TEMP*EZD                                        EXP06250
C     QRZAV = (QRZ(K,L) + QRZA)/2.0 + TEMP*ERZD                                    EXP06260
C     DENER IS THE INTERNAL ENERGY INCREASE IN THE PLASTIC-ELASTIC (I.E.           EXP06270
C     [illegible] IMPACT(BAR) PER UNIT OF ORIGINAL VOLUME                          EXP06280
C     DENER =((2.0*QRAV + QZAV)*DERAV +(QRAV+2.0*QZAV)*DEZAV                       EXP06290
C     * + 2.0*DERZAV*QRZAV - PAV*DVELM/VOL(K,L))*1.0E-6                            EXP06300
C     DENER IS CHANGED FROM GAS/UNIT OF SPECIFIC VOLUME TO MB-CC/GRAM              EXP06310
C     DENER = DENER*1.0E-06  /(DDA*XA+DDL*XL+DDS*XS)                               EXP06320
      GAA = [illegible]*TEM(K,L)-.000011049*TEM(K,L)**2                            EXP06330
      GAA=[illegible]*TEM(K,L)-195500./TEM(K,L)**2                                 EXP06340
      GAA=0.21*[illegible]*(.21*.00258+.79*.001)*TEM(K,L)-.21*187700.              EXP06350
     * /TEM(K,L)**2                                                                EXP06360
      CV = GAA - 1.987                                                             EXP06370
            AG1 = 1.475/2.9855
            AG2 = 0.01150/2.9855
            AG3 = 0.16622/2.9855
            AG4 = 0.4[illegible]/2.9855
            AG5 = 0.1[illegible]/2.9855
              AG6 = 0.16622/2.9855
              AG7 = 2.3443/2.9855
      [illegible] = AG1      *(8.22+0.00015*TEM(K,L)+0.0000013*TEM(K,L)**2)        EXP06380
     *[illegible] (6.[illegible]+0.000[illegible]*TEM(K,L))+AG5*(5.60+0.00120*TEM(K,L))
     *[illegible] *(10.34+0.00274*TEM(K,L)-195500/TEM(K,L)**2)+                    EXP06390
     *[illegible] *(6.5+0.001*TEM(K,L))+AG6      *0.390*2.9855                     EXP06400
      CVG[illegible] = [illegible]      *0.39[illegible]*2.9855  *AG7      *1.987   EXP06410
     *[illegible]      *0.3[illegible]*2.9855  /(1.+SOL(14)*SOL(11)*TEM(K,L))      EXP06420
      CVG(K,L) = ((GAA-1.987)*AN1(K,L)+(AN(K,L)-AN1(K,L))*CVGPN)/AN(K,L)           EXP06430
      GAA = GAA*AN1(K,L)/AN(K,L)+GIGM*(AN(K,L)-AN1(K,L))/AN(K,L)                   EXP06440
      GAA = GAA/CVG(K,L)                                                           EXP06450
      CV = CVG(K,L)                                                                EXP06460
            GA = GAA                                                               EXP06470
      [illegible](K,L) = GAA                                                       EXP06480
C     TIT = ((PPA+1.0*1.0000E6)/(P(K,L)+1.0*1.0000E6))**((GAA-1.0)/GAA)+           EXP06490
C     [illegible] TEM(K,L)                                                         EXP06500
C     [illegible] = TIT                                                            EXP06510
C     [illegible](K,L)=(ZN/TEM(K,L))**(GA/(GA-1.))*P(K,L) *1.0204E-6                EXP06520
C     [illegible](K,L)=(ZN/TEM(K,L))**(GA/(GA-1.))*(P(K,L) *1.0204E-6+1.0)-1.0E     EXP06530
C     [illegible](K,L)=(ZN/TEM(K,L))**(GA/(GA-1.))*(P(K,L) *1.0000E-6+1.0)-1.0E     EXP06540
C     [illegible](K,L) = TA                                                        EXP06550
C     [illegible]                                                                  EXP06560
C     [illegible]                                                                  EXP06570
C     [illegible] = 1./GL                                                          EXP06580
C     [illegible] = 1./GS                                                          EXP06590
C     TA = XAA *(PA+1.0000E-6+1.0)**(-1./GAA)                                      EXP06600
C     TL = XL*(XL*(PA+1.0000E-6    )+1.)**(-1./GL)                                 EXP06610
C     TS = XS*(XS*(PA+1.0000E-6    )+1.)**(-1./GS)                                 EXP06620
C     [illegible] = 1./((TA+TL+TS)-1.0                                             EXP06630
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      [illegible](K,L) = TAV - [illegible]TA                                  EXP06640
      [illegible](K,L) = TA                                                   EXP06650
      [illegible](K,L) = VAN                                                  EXP06660
      VAN1 = [illegible](K,L)*0.[illegible]                                   EXP06670
                     VAN-(PA*1.0E-6+1.0)**(-1./GAA)/DDA*28.96                 EXP06680
C     VAN1 = (P(K,L)*1.0000   6+1.0)**(-1./GAA)/DDA*28.96                     EXP06690
C     GAA=0.21*6.27+.79*6.5+(.21*.00255+.79*.001)* DP(K,L)-.21*137700.        EXP06700
C    / DP(K,L) [illegible]                                                    EXP06710
C     GAAA = GAAA/(GAAA-1.987)                                                EXP06720
CCCCC VAN1 = (P(K,L)+1.0000   6+1.0)**(-1./GAAA)/DDA*28.96                    EXP06730
      VAN1 = [illegible](K,L)                                                 EXP06740
C     TIT = T[illegible](K,L)-32.05000*TEM(K,L)/CV/VAN*(1.+650.*TEM(K,L)**(-.5)) EXP06750
C    /VAN)*EXP(.1[illegible]*TEM(K,L) (-.5)/VAN))*(VAN-VAN1)                  EXP06760
C     TIT = T[illegible](K,L)-32.05000*TEM(K,L)/CV/VAN*(1.+41+5.8*(TEM(K,L)      )EXP06770
C    *+(-.5)/VAN)*EXP(.16*145.8*(TEM(K,L)        )**(-.5)/VAN))*(VAN-VAN1)EXP06780
C     TIT = TI[illegible](K,L)-32.05000*TEM(K,L)/CV/VAN*(1.+41*5.8*(TEM(K,L)+400.)EXP06790
C    ***(-.5)/VAN+EXP(.16*145.9*(TEM(K,L)+400.)**(-.5)/VAN))*(VAN-VAN1)EXP06800
      WRITE(6,605) K,L,VAN1,VAN,TIT                                           EXP06810
  605 FORMAT(1H ,2I5,3F14.7)                                                  EXP06820
      K[illegible] 1                                                          EXP06830
C***  IF (KP .NE. 1) GAA = 0.21*6.27+.79*6.5+(.21*.00255+.79*.001)*TIT1 EXP06840
C***   -.21*137700./TIT1**2                                                   EXP06850
C***  IF (KP .NE. 1) CV = GAA-1.987                                           EXP06860
C***  IF (KP .NE. 1) PP[illegible](K,L) = GAA/(GAA-1.987)                     EXP06870
C     TEM(K,L) = TEM(K,L) - TDOWN(K,L)                                        EXP06880
 1005 CONTINUE                                                                EXP06890
      XAK = 1[illegible]0.                                                    EXP06900
      XAK = 300.0                                                             EXP06910
      [illegible]TA = -11.0                                                   EXP06920
      [illegible]TA = -7.0                                                    EXP06930
      [illegible]TA = -[illegible].0                                          EXP06940
      XAK = 10.**(0.79*380.+0.21*330.)                                        EXP06950
      XAK1 = XAK
      [illegible]TA = 0.10                                                    EXP06960
      XAK = [illegible]0.                                                     EXP06970
      XAK = A[illegible](XAK1-650.) + 650.
      IF(([illegible]TA*XAK*TEM(K,L)**(-0.5)/VAN) .GT. 10.0) VAN = (BETA*XAK*
     +TEM(K,L)**(-0.5))/10.0
      TIT = T[illegible](K,L)-32.05000*TEM(K,L)/CV/VAN*(1.+XAK *TEM(K,L)**(-.5)) EXP06980
     /VAN*EXP(BETA*XAK *TEM(K,L)**(-.5)/VAN))*(VAN-VAN1)                      EXP06990
C    [illegible]  /10405.0                                                    EXP07000
C    +[illegible]XAK *TEM(K,L)**0.5/VAN**2/CV*(1.+XAK *BETA*TEM(K,L)EXP07010
C    *(-0.5)/VAN)*EXP(BETA*XAK *TEM(K,L)**(-0.5)/VAN)*(VAN-VAN1)*             EXP07020
C    [illegible]/10405.0                                                      EXP07030
      IF (TIT .LE. 0.0) TIT = 300.+KP*10.                                     EXP07040
      IF ((BETA*XAK*TIT**(-.5)/VAN) .GE. 10. ) VAN=BETA*XAK*TIT**(-.5)
     /10.
C     [illegible](1H0,I5,[illegible]1E7.3[illegible])                         EXP07050
      [illegible] = (P*1.0[illegible] + 1.0)/1.01325                          EXP07060
C     [illegible]*(1.0+XAK *TIT**(-.5)/VAN*EXP(BETA*XAK *TIT**(-.5)/VAN))     EXP07070
C     [illegible]TIT/VAN                                                      EXP07080
C     [illegible]TIT/VAN*[illegible](1.0+XAK *TIT**(-.5)/VAN*(2.0+BETA*XAK    EXP07090
C    *TIT**(-.5)/VAN)*EXP(BETA*XAK *TIT**(-.5)/VAN))                          EXP07100
      IF ( ABS(F[illegible]) .LT. .1   ) GO TO 1006                           EXP07110
      V[illegible] = VAN - [illegible]/[illegible]                            EXP07120
      IF (K .EQ. 17 .AND. K .EQ. 10 .AND. L.EQ. 15) WRITE(6,7707)
     [illegible]VAN,VAN1,XAK,TIT,PP,[illegible]
 7707 FORMAT(1H ,[illegible]E17.21[illegible])
      IF ( [illegible]((VA[illegible]-VAN)/VAN) .LT. 0.200) GO TO 1006         EXP07130
 1010 CONTINUE                                                                EXP07140
      IF ( [illegible] .LE. [illegible]) GO TO 1007                           EXP07150
      T[illegible] = TIT                                                      EXP07160
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      GO TO 7003
 7007 EXP = 1./SEL(15)**2*RXZDV**2*(SEL(15)-VVS)                          EXP08180
      EXP = EQ(4) - EXP                                                   EXP08190
      IV = IV + 1                                                         EXP08200
      GO TO 7002                                                          EXP08210
 7004 CONTINUE                                                            EXP08220
      IF(TIT .LT. TMIN) EQ(5) = EQ(5)                                     EXP08230
      IF(TIT .LT. TMIN) GO TO 7009                                        EXP08240
      VAL = (XXA(K,L) + XXL(K,L))*VN                                      EXP08250
      IF (VAL .LE. 0.0) EQ(6) = 0.0                                       EXP08260
      VS = EQ(6)*WN1S*XMS(K,L)                                            EXP08270
      DVS = VVS*WNS*XMS(K,L) - WNS*XMS(K,L)/XDS(K,L)                      EXP08280
      XDS(K,L) = 0.0                                                      EXP08290
      IF ( EQ(6)     .GT. 0.00001) XDS(K,L) = 1./EQ(6)                    EXP08300
      IF ( DVS .GE. VAL) WRITE(6, 7778) DVS, VAL                          EXP08310
 7778 FORMAT(1H0,'    DVS .GT. VAL',6E13.6)                                EXP08320
      IF ( DVS .GT. VAL) GO TO 8000                                       EXP08330
      VV1=XXA(K,L)*VN+ EQ(7)*(WNS - WN1S)*XMS(K,L)                        EXP08360
      IF (EQ(7) .LE. 0.0) VV1=(XXA(K,L)+XXS(K,L))*VN
      G16=AG1      *(8.22+0.00015*EQ(5)+0.00000134*EQ(5)**2)              EXP08430
     *+AG2*(8.62+0.00081*EQ(5))+AG5*(8.60+0.00120*EQ(5))
     *+AG3      *(10.34+0.0027*EQ(5)-195500./EQ(5)**2)                   EXP08440
     *+AG4      *(8.5+0.001*EQ(5))+AG6      *0.390*2.9855                 EXP08450
      G16=G16-AG6      *0.39*2.9855   *AG7      *1.987                    EXP08460
     *+AG8      *0.39*2.9855   /(1+SEL(14)*SEL(11)*EQ(5))                 EXP08470
      AN2=(WNS-WN1S)*XMS(K,L)/XMA*2.9855                                  EXP08480
      IF (WN1S .GT.  SELW) AN2 = 0.0
      CVG=G1-AG1      *(8.22+0.00015*TIT+0.00000134*TIT**2)               EXP08490
     *+AG2*(8.62+0.00081*TIT)+AG5*(8.60+0.00120*TIT)     +
     *+AG3      *(10.34+0.0027*TIT-195500./TIT**2)                       EXP08500
     *+AG4      *(8.5+0.001*TIT)-AG7      *1.987+AG6      *0.39           EXP08510
     *+AG8      /(1+SEL(14)*SEL(11)*TIT)                                 EXP08520
      GAAN1=0.21*3.27+0.79*6.5+(0.21*0.00258+0.79*0.001)*TIT              EXP08530
     *-0.21*1.7700./TIT**2                                                EXP08540
      CVG(K,L)=((GAAN1-1.987)*AN1(K,L)+(AN(K,L)-AN1(K,L))*CVGPN1)         EXP08550
     */AN(K,L)                                                            EXP08560
      IF=(AN(K,L)-CVG(K,L))*TIT+G16*AN2*EQ(5)+(WNS-WN1S)*XMS(K,L)*HCB)/   EXP08570
     *(AN(K,L)*CVG(K,L)+AN2*G16)                                          EXP08580
      IF(K.EQ.2 .AND. L.EQ.15) WRITE (6,3000) N,K,L,GANN1,CVG(K,L),       EXP08590
     *AN(K,L),EQ(5),WNS,N,WN1S                                            EXP08600
      AN(K,L)=AN(K,L)+AN2                                                 EXP08610
      P(K,L)=P(K,L)-IF*82.05666/VV1                                       EXP08620
      P(K,L)=P(K,L)+1.9132E+06                                            EXP08630
      VEN = VN - VV1 - VS
      IF (IPHASE .EQ. 2) VEN = 0.0
      IF (IPHASE .EQ. 2) GO TO 7999
      IF ( VEN .LE. 0.0)
     *VEN = XL*VAL(K,L)*(GL*9.325*(P(K,L)*1.0E-05                )/(DL*CL  EXP08340
     *EQ(5) + 1.) *(-1./GL)                                               EXP08350
 7999 CONTINUE
      XDA(K,L) = XMA/VV1                                                  EXP08370
      XXA(K,L) = VV1/VN                                                   EXP08380
      XDL(K,L) = 0.0
      IF (VEN .GT. 0.0)
     *XDL(K,L) = XDL(K,L)*XXL(K,L)*VN/VEN                                 EXP08390
      XXL(K,L) = VEN/VN                                                   EXP08400
      EQ(5)                EQ(5)                                          EXP08410
      XXS(K,L) = VS/VN                                                    EXP08420
      XDS(K,L) = 0.0
      IF (VS .GT. 0.0) XDS(K,L) = WN1S*XMS(K,L)/VS
      TIT = TIT
      TIT(K,L) = TIT                                                      EXP08640
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      [illegible] (K,L) = [illegible](5)                                          EXP08650
      IF (K.EQ.[illegible] .AND. L .EQ.15) WRITE (6,3000) N,K,L,TF,PGP,VV1,       EXP08660
      [illegible](K,L),XXS(K,L),N,PA ,ITEM                                        EXP08660
      GO TO 7010                                                                  EXP08630
 7000 CONTINUE                                                                    EXP08690
      IF (K .EQ. 3 .AND. L .EQ. 15)                                               EXP08700
     *WRITE (6,7777) V1,(EQ(II),II=1,7)                                           EXP08710
      IF (K .EQ. 5 .AND. L .EQ. 15)                                               EXP08720
     *WRITE (6,7777) VA,DVS,VVS,XXA(K,L),XLA(K,L),XXL(K,L),XDL(K,L)               EXP08730
     *[illegible](K,L),XXS(K,L)                                                   EXP08740
 7777 FORMAT(1H0,[illegible]12.5)                                                 EXP08760
      TEM(K,L) = TIT + EQ(5)                                                      EXP08770
      TEM(K,L) = TIT + EQ(5) +TPRES                                               EXP08780
      PS(K,L) = EQ(4)                                                             EXP08790
      PS(K,L) = EQ(4) + PS(K,L)                                                   EXP08800
      P(K,L) = PA + EQ(4)                                                         EXP08810
      P(K,L) = PA + EQ(4)*1.0E+12                                                 EXP08820
      TEM(K,L) = TIT + EQ(5) +TPRES                                               EXP08830
      TEM(K,L) = TIT + EQ(5)                                                      EXP08840
 7111 CONTINUE                                                                    EXP08850
 7070 CONTINUE                                                                    EXP08870
      TBURN(K,L) = EQ(5) -TINIT                                                   EXP08860
        IF (TBURN(K,L) .LE. 0.0) TBURN(K,L) = 0.0                                 EXP08880
      TEM(K,L) = TIT                                                              EXP08890
 7011 P(K,L) = PA                                                                 EXP08900
 7010 CONTINUE                                                                    EXP08910
      PS(K,L) = [illegible]                                                       EXP08920
      IF (N.EQ.[illegible].OR.N.EQ.NB1) WRITE(6,3000) N,K,L,TBURN(K,L),           EXP08930
      [illegible](K,L),TEM(K,L),EQ(1),EQ(3)                                       EXP08940
      ENERGY(K,L) = VAN                                                           EXP08950
 7070 CONTINUE                                                                    EXP08960
      [illegible](K,L) = [illegible]                                              EXP08970
      [illegible](K,L) = [illegible]                                              EXP08980
      [illegible](K,L) = [illegible]                                              EXP08990
      [illegible](K,L) = [illegible]                                              EXP09000
      [illegible](K,L) = [illegible]                                              EXP09010
      [illegible](K,L) = [illegible]                                              EXP09020
      IF (IPHASE .EQ. 2)                                                          EXP09030
     *[illegible](ABS(CCR(K,L)-CCR(K-1,L)),ABS(CCR(K,L)-CCR(K,L-1)),
     *[illegible](CCR(K-1,L-1)-CCR(K-1,L)),ABS(CCR(K-1,L-1)-CCR(K,L-1)),
     *[illegible](CCZ(K,L)-CCZ(K-1,L)),ABS(CCZ(K,L)-CCZ(K,L-1)),
     *[illegible](CCZ(K-1,L-1)-CCZ(K-1,L)),ABS(CCZ(K-1,L-1)-CCZ(K,L-1)))
      [illegible](K,L) = [illegible]*DX*(W14-W22)                                 EXP09020
      [illegible](K,L) = [illegible]*DX*(W45-W12)                                 EXP09030
      [illegible](K,L) = [illegible]*DX*ERZD                                      EXP09020
      [illegible](K,L) = [illegible]*DX*ERD                                       EXP09030
      [illegible](K,L) = [illegible]*DX*ERZD                                      EXP09040
 [illegible] CONTINUE                                                             EXP09050
 [illegible] CONTINUE                                                             EXP09060
      [illegible] CONDITION AT K = 2 **** SLIDE ****                              EXP09070
      [illegible]                                                                 EXP09080
      [illegible] = TEM(3,L)                                                      EXP09090
      [illegible] = P(3,L)                                                        EXP09100
      [illegible] = [illegible](3,L)                                              EXP09110
      [illegible] = [illegible](3,L)                                              EXP09120
      [illegible] = [illegible](3,L)                                              EXP09130
      [illegible] = [illegible](3,L)                                              EXP09140
      [illegible] = [illegible](3,L)                                              EXP09150
      [illegible] = [illegible](3,L)
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      [illegible]
      [illegible]
[illegible]   TAKEN OUT                                                   EXP09160
  173 CONTINUE                                                            EXP09170
      BOUNDARY CONDITION AT L=2 (L = NOL)?  [illegible] SLIDE [illegible]  EXP09180
      DO 173 K=2,NOK                                                      EXP09190
      IF (K .GE. KPJW1) GO TO 919
[illegible]   TAKEN OUT                                                   EXP09200
      P(K,NOL) = 0.0                                                      EXP09210
      Q(K,NOL) = 0.0                                                      EXP09220
      QR(K,NOL) = 0.0                                                     EXP09230
      QZ(K,NOL) = 0.0                                                     EXP09240
      QRZ(K,NOL) = 0.0                                                    EXP09250
      QL(K,NOL) = 0.0                                                     EXP09260
      QK(K,NOL) = 0.0                                                     EXP09270
      QKL(K,NOL) = 0.0
      QDL(K,NOL) = 0.0
      QDK(K,NOL) = 0.0
      GO TO 173
  919 CONTINUE
      DO 1-12 L = NOLL,NOL
      QZ(K,  L)= 0.0
      P(K,  L)=0.0
      QRZ(K,  L)= 0.0
      QL(K,  L) = 0.0
      QK(K,  L) = 0.0
      QR(K,  L)  0.0
      QZ(K,  L)= 0.0
      QKL(K,L) = 0.0
      QDK(K,L) = 0.0
      QDL(K,L) = 0.0
[illegible]   CONTINUE
  173 CONTINUE                                                            EXP09280
                                                                          EXP09290
      SHIFTING OF COORDINATE                                              EXP09300
      DO 1[illegible] K=1, NOK                                            EXP09310
      DO 1[illegible] L = 1, NOL                                          EXP09320
      DSR(K,L) = DSR(K,L) + U(K,L)*DT                                     EXP09330
      DSZ(K,L) = DSZ(K,L)+V(K,L)*DT                                       EXP09340
      CSR(K,L) = CSR(K,L)+DSR(K,L)                                        EXP09350
      CSZ(K,L) = CSZ(K,L)+DSZ(K,L)                                        EXP09360
      IF ([illegible] .AND. N .LE. 102) WRITE(6,7779)N,K,L,CSR(K,L),
     [illegible] Z(K,L),U(K,L),V(K,L),DSR(K,L),DSZ(K,L)
  1[illegible] CONTINUE                                                   EXP09370
      IF ( K .GE. KPJW) CSZ(K,NOL) = CSZ(K,NL1)+PJL                       EXP09380
  1[illegible] CONTINUE                                                   EXP09390
      IF ( [illegible](KPJW1,NL1) .GE. PJW) GO TO 193                     EXP09400
      CSR(KPJW1, NL1) = PJW                                               EXP09410
      U(KPJW1,NL1) = 0.0                                                  EXP09420
      V(KPJW1,NL1) = 0.0                                                  EXP09430
  1[illegible] CONTINUE                                                   EXP09440
      IF((N/[illegible]) .NE. 0) GO TO 1003                               EXP09450
      [illegible] N/[illegible] + 1                                       EXP09460
      Y1(M) = P(KP1,LP1) +1.0E-9                                          EXP09470
      Y2(M) = P(KP2,LP2) +1.0E-9                                          EXP09480
      Y3(M) = P(KP3,LP3) +1.0E-9                                          EXP09490
      Y4(M) = P(KP4,LP4) +1.0E-9                                          EXP09500
      Y5(M) = P(KP5,LP5) +1.0E-9                                          EXP09510
      X1(M) = [illegible](KP1,LP1) +1.0E-3                                EXP09520
      X2(M) = [illegible](KP2,LP2) +1.0E-3                                EXP09530
      X3(M) = [illegible](KP3,LP3) +1.0E-3                                EXP09540
      X4(M) = [illegible](KP4,LP4) +1.0E-3                                EXP09550
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      XS(2) = T [illegible](K+3,LP3) *1.0E+3
      XXX(2) = T[illegible]*1.0E6
 1005 CONTINUE
C
      PRINT [illegible]
      PTAP (1) = P(NP1,LP1)
      PTAP (2) = P(NP2,LP2)
      PTAP (3) = P(NP3,LP3)
      PTAP (4) = P(NP4,LP4)
      PTAP (5) = P(NP5,LP5)
      IF (IZ*[illegible]KTA .NE. N) GO TO 142
      [illegible] = IZ/(KNTA - 0.001)
C     [illegible] = [illegible](KNTA + 0.001)
C     IF ([illegible] .LE. 0) GO TO 142
C     [illegible] = [illegible] + 1
      [illegible] = TIM*1.0E6
      [illegible] = TIM*1.0E6
      [illegible] LLLLL = 1, [illegible]
      [illegible] LLLLL*NDATA
      [illegible]                 - P(3,6+LLLLL) *1.0E-6
      [illegible]                 - TIM(3,6+LLLLL)
 [illegible] CONTINUE
  142 IF ((IZ/[illegible])*KTS .NE. N) GO TO 143
      [illegible] SECOND MOTION *****
C
 1001 CONTINUE
      WRITE (6, 100)
      WRITE (6, 104)
      WRITE (6,101) N, TIME
  101 FORMAT(1H0,5X,'N =',I5,5X,'TIME =',E12.5)
      WRITE (6, 105) PMA,KMA,LMA,NMA
  105 FORMAT(1H ,50X,4HPMX=,E15.7,6H      KMX=,I4,6H      LMX=,I4,
     [illegible]
      WRITE (6, 140)
  140 FORMAT(1H0,1X,[illegible] L, 2X,3HDSR,6X,7HDSZ       ,9H      U     ,9H      V,
     [illegible]                                 10H       [illegible]  ,10H        QZ
     [illegible] ,10H PRESSURE ,[illegible]             ,10H      [illegible]  ,11HTEMPERATURE/)
     [illegible]  ,10H       [illegible]  ,10H      QK      ,10H     QL
      DO [illegible] K=KOUT1,KOUT2,KSP
      DO [illegible] L=LOUT1,LOUT2,LSP
      PPPP = P(K,L)*1.0E-6
      DENS = [illegible](K,L)/VOLU([illegible](K,L),COR(K-1,L),COR(K-1,L-1),COR(K,L-1),CL
     [illegible](K,L),COZ(K-1,L),COZ(K-1,L-1),COZ(K,L-1))
      IF (ABS(U(K,L)) .LT. 0.00000001) GO TO 1[illegible]
      AV = ATAN(V(K,L)/U(K,L))*180./3.141592
      GO TO [illegible]
 1[illegible] AV = 0.0
 1[illegible] WRITE ([illegible])K,L,DSR(K,L),DSZ(K,L),U(K,L),V(K,L),DENS,PPPP,Q(K,L),
     * QR(K,L),QZ(K,L),QRZ(K,L),QK(K,L),QL(K,L)    , TEM(K,L)
     * [illegible](K,L),QZ(K,L),QRZ(K,L),QK(K,L),QL(K,L)
      [illegible](K,L)*1000000.
      WRITE (6,[illegible])   WGAS(K,L),DGAS(K,L),XGAS(K,L),[illegible]    ,WO(K,L)
      WRITE (6,[illegible]) XXA(K,L),XDA(K,L),XXL(K,L),XXS(K,L),XDS(K,L),
     [illegible](K,L) ,[illegible](K,L)
 1[illegible] CONTINUE
 1[illegible] CONTINUE
 1[illegible] FORMAT(1H ,[illegible],F10.1,7E9.2)
      WRITE (6,[illegible]) T61,T62,T63,T64,T65
      IF ([illegible] .LT. 0.[illegible]) GO TO 1002
      IF ([illegible] .LT. 0.[illegible]) GO TO 1002

  143 CONTINUE
      IF ( IZ/[illegible] .NE. [illegible]) GO TO 14[illegible]
```

```
7000 CONTINUE                                                          EXP10150
     IF(IPRE.LT.0.0) GO TO 2311                                        EXP10160
     IOI = -1                                                          EXP10170
     DO 4100 L = [illegible], NL1                                      EXP10180
     IOI = -IOI                                                        EXP10190
     DO 4110 KK = [illegible], NK1                                     EXP10200
     IF ( IOI .LT. 0) GO TO 4120                                       EXP10210
     K = KK                                                            EXP10220
     GO TO 4130                                                        EXP10230
4120 K=NK1+1-KK                                                        EXP10240
4130 XPO = [illegible](K,L)                                            EXP10250
     YPO = [illegible](K,L)                                            EXP10260
     XPE = XPO+U(K,L)*SCAV                                             EXP10270
     YPE = YPO+V(K,L)*SCAV                                             EXP10280
     NAAA = ([illegible](K,L) + 299.99)/300.                           EXP10290
     NAAA = ([illegible](K,L) + 499.99)/500.                           EXP10300
     NAAA = ([illegible](K,L) + 999.99)/1000.0                         EXP10310
     NAAA = (P(K,L)+1.0E-6+5999.99)/6000.                              EXP10320
     IF ( NAAA .GE. 15) NAAA = 15                                      EXP10330
     CALL SYMBOL(XPO,YPO,0.21,NAAA,0.0,-1)                             EXP10340
     CALL SYMBOL(XPO,YPO,0.105,NAAA,0.0,-1)                            EXP10350
CCCC CALL SYMBOL(XPO,YPO,0.0303,1,0.0,-1)                              EXP10360
CCCC CALL PLOT(XPO,YPO,2)                                              EXP10370
CCCC CALL PLOT(XP[illegible],YP[illegible],2)                          EXP10380
4110 CONTINUE                                                          EXP10390
4100 CONTINUE                                                          EXP10400
     CZPEO = [illegible](2,NL1) + 1.0                                  EXP10410
     CALL PLOT(CCR(KPJW,NJL),CZPEJ,3)                                  EXP10420
     CALL PLOT(CCR(KPJA,NL1),CCZ(KPJA,NL1),2)                          EXP10430
     CALL PLOT(CCR(2,NL1),CCZ(2,NL1),2)                                EXP10440
     GTIM = TIME-1.0                                                   EXP10450
     CALL [illegible](1.0,-0.5,0.25,GTIM,0.0,1)                        EXP10460
     NOP = NOP + 1                                                     EXP10470
     IF ( NOP .NE. NOPA) GO TO 4300                                    EXP10480
     NOP = 0                                                           EXP10490
     [illegible] = [illegible](1+NOPA)                                 EXP10500
     ORY = -[illegible]                                                EXP10510
     GO TO 4310                                                        EXP10520
4300 [illegible]                                                       EXP10530
     [illegible]Y = 0.0                                                EXP10540
4310 CALL PLOT([illegible], [illegible],-3)                            EXP10550
2311 CONTINUE                                                          EXP10560
     IF ( [illegible] .GE. 0) GO TO 7001                               EXP10570
1[illegible] CONTINUE                                                  EXP10580
1[illegible] CONTINUE                                                  EXP10590
1[illegible] CONTINUE                                                  EXP10600
                                                                       EXP10610
1002 CONTINUE                                                          EXP10620
     WRITE (6, 151) N, TIME                                            EXP10630
     WRITE (6, 152) PMA,KMA,LMA,NMA                                    EXP10640
     [illegible] = [illegible]*1.0E-6                                  EXP10650
     IF ( NTA .LT. [illegible]) CALL PLTC(3,XP,NTA,LLLLL1,NTA,1)       EXP10660
     IF ( NTA .LT. [illegible]) WRITE(6,9090)                          EXP10670
9090 FORMAT(1H0,35X,'TIME(MICROSECONDS) - PRESSURE(BAR)'/42X,'1---K=3,L=EXP10680
     .7'/42X,'2---K=3,L=8'/42X,'3---K=3,L=9'/42X,'4---K=3,L=10'/        EXP10690
     *  [illegible]X,'5---K=3,L=11'/42X,'6---K=3,L=12'/42X,'7---K=3,L=13'/ EXP10700
     [illegible]X,'[illegible]---K=3,L=14'/42X,'9---K=3,L=15')          EXP10710
     IF ( NTA .LT. [illegible]) CALL PLTC(4,WRT,NTA,LLLLL1,NTA,1)      EXP10720
     IF ( NTA .LT. [illegible]) WRITE(6,9091)                          EXP10730
9091 FORMAT(1H0,[illegible]X,'TIME(MICROSECONDS) - TEMPERATURE(K)'/42X,'1---K=3,L=EXP10740
     [illegible]'/42X,'2---K=3,L=8'/42X,'3---K=3,L=9'/42X,'4---K=3,L=10'/ EXP10750
     *  [illegible]X,'5---K=3,L=11'/42X,'6---K=3,L=12'/42X,'7---K=3,L=13'/
```

```
      [illegible]                                                       EXP10760
      [illegible]                                                       EXP10770
      IF(IIPLOT.[illegible]) GO TO 2312                                 EXP10780
      CALL PLOT([illegible])                                            EXP10790
      IPLOT = 0 PRESSURE VS TIME                                        EXP10800
      IPLOT = 1 TEMPERATURE VS TIME                                     EXP10810
      [illegible]                                                       EXP10820
      IPLOT = 0                                                         EXP10830
      IF(KTA .LT. [illegible])                                          EXP10840
      CALL PWAV(Y1,Y2,Y3,Y4,Y5,XXX,N,IPLOT)                             EXP10850
      IPLOT = 1                                                         EXP10860
      IF(KTA .LT. [illegible])                                          EXP10870
     *CALL PWAV(X1,X2,X3,X4,X5,XXX,N,IPLOT)                             EXP10880
      CALL PLOT(0.0,0.0,[illegible])                                    EXP10890
 2312 CONTINUE                                                          EXP10900
 2000 STOP                                                              EXP10910
      END
```

```
      FUNCTION DELTV(RA,RB,RC,RD,ZA,ZB,ZC,ZD,UA,UB,UC,UD,VA,VB,VC,VD,DT)EXP10920
      RZABC=(RA-RB)*(ZA-ZC) - (RA-RC)*(ZA-ZB)                           EXP10930
      RZACD = (RA-RC)*(ZA-ZD) - (RA-RD)*(ZA-ZC)                         EXP10940
      UZABC = (UA-UB)*(ZA-ZC) -(UA-UC)*(ZA-ZB)                          EXP10950
      UZACD = (UA-UC)*(ZA-ZD) - (UA-UD)*(ZA-ZC)                         EXP10960
      RVABC = (RA-RB)*(VA-VC)-(RA-RC)*(VA-VB)                           EXP10970
      RVACD = (RA-RC)*(VA-VD)-(RA-RD)*(VA-VC)                           EXP10980
      UVABC = (UA-UB)*(VA-VC) - (UA-UC)*(VA-VB)                         EXP10990
      UVACD = (UA-UC)*(VA-VD) - (UA-UD)*(VA-VC)                         EXP11000
      DELTV=((UA+UB+UC)*(RZABC+UVABC+0.25*DT*DT)+(UA+UC+UD)*(RZACD+UVACDEXP11010
     1+0.25*DT*DT)+(RA+RB+RC)*(UZABC+RVABC)+(RA+RC+RD)*(UZACD+RVACD))*DTEXP11020
     */6.0                                                              EXP11030
      RETURN                                                            EXP11040
      END                                                               EXP11050
```

```
FUNCTION VOLUME(RA,RB,RC,RD,ZA,ZB,ZC,ZD)                                EXP11100
RANGE=(RA-RB)*(ZA-ZC)-(RA-RC)*(ZA-ZB)                                   EXP11110
RZACD=(RA-RC)*(ZA-ZD)-(RA-RD)*(ZA-ZC)                                   EXP11120
VOLUME=((RA+RB+RC)*RZABC+(RA+RC+RD)*RZACD)/6.0                          EXP11130
VOLUME = ABS(VOLUME)                                                    EXP11140
RETURN                                                                  EXP11150
END                                                                     EXP11160
```

```
      [illegible]
      [illegible]                                                        EXP11170
      [illegible]                                                        EXP11180
      [illegible]                                                        EXP11190
      [illegible]                                                        EXP11200
      [illegible]                                                        EXP11210
      [illegible]                                                        EXP11220
      [illegible]                                                        EXP11230
      [illegible] CARD MUST BE PUT AFTER THE 'FINISH' CARD IN INPUT DATA  EXP11240
      [illegible] GO TO 1000                                             EXP11250
      [illegible]                                                        EXP11260
      [illegible]                                                        EXP11270
      [illegible]                                                        EXP11280
      [illegible]                                                        EXP11290
      [illegible]                                                        EXP11300
      [illegible]                                                        EXP11310
      [illegible]                                                        EXP11320
      [illegible]                                                        EXP11330
      [illegible]                                                        EXP11340
      [illegible]                                                        EXP11350
      [illegible]                                                        EXP11360
      [illegible]                                                        EXP11370
      [illegible]                                                        EXP11380
      [illegible]                                                        EXP11390
      [illegible]                                                        EXP11400
      [illegible]                                                        EXP11410
      [illegible]                                                        EXP11420
      [illegible]                                                        EXP11430
      [illegible]                                                        EXP11440
      [illegible]                                                        EXP11450
      [illegible]                                                        EXP11460
      [illegible]                                                        EXP11470
      [illegible]                                                        EXP11480
      [illegible]                                                        EXP11490
      [illegible]                                                        EXP11500
      [illegible]                                                        EXP11510
      [illegible]                                                        EXP11520
      [illegible] GO TO 20                                               EXP11530
      [illegible]                                                        EXP11540
      [illegible]                                                        EXP11550
      [illegible] GO TO 41                                               EXP11560
      [illegible]                                                        EXP11570
      [illegible] GO TO 2[illegible]                                     EXP11580
      [illegible]                                                        EXP11590
      [illegible]                                                        EXP11600
      [illegible]                                                        EXP11610
      [illegible] GO TO 24                                               EXP11620
      [illegible]                                                        EXP11630
      [illegible]                                                        EXP11640
      [illegible]                                                        EXP11650
      [illegible]                                                        EXP11660
      [illegible]                                                        EXP11670
      [illegible]                                                        EXP11680
      [illegible]                                                        EXP11690
      [illegible]                                                        EXP11700
      [illegible]                                                        EXP11710
      [illegible]                                                        EXP11720
      [illegible]                                                        EXP11730
      [illegible]                                                        EXP11740
      [illegible]                                                        EXP11750
      [illegible]                                                        EXP11760
      [illegible]                                                        EXP11770
      [illegible]                                                        EXP11780
```

```
   41 CONTINUE                                                           EXP11790
      SP(I) = P                                                          EXP11800
      SPC(I) = [illegible]                                               EXP11810
      [illegible](I) = [illegible] - 1.                                  EXP11820
   40 CONTINUE                                                           EXP11830
  510 FORMAT(1H ,[illegible]E15.7)                                       EXP11840
      IF ([illegible] .GE. [illegible]) GO TO 21                         EXP11850
      [illegible]                                                        EXP11860
      [illegible] = [illegible] RAT                                      EXP11870
      I = I + 1                                                          EXP11880
      GO TO 2000                                                         EXP11890
   21 CONTINUE                                                           EXP11900
      [illegible] = [illegible]                                          EXP11910
      CALL [illegible](P[illegible],NO,KP,IP,[illegible],PP,CF)          EXP11920
      WRITE (6,5)                                                        EXP11930
    5 FORMAT(1H1,[illegible]X,'CF1',12X,'CF2',12X,'CF3',12X,'CF4',12X,'CF5') EXP11940
      WRITE (6,400)(CF(JJ),JJ=1,5)                                       EXP11950
  400 FORMAT(1H ,[illegible]E15.7)                                       EXP11960
      JJ = [illegible]                                                   EXP11970
      DO [illegible] J = 1, [illegible]                                  EXP11980
      [illegible] = [illegible](KP+1)                                    EXP11990
      DO 47 [illegible] = 1, KP                                          EXP12000
   47 [illegible] (J)[illegible](KP-IN+1)                                EXP12010
      [illegible](J+JJ)=[illegible]                                      EXP12020
   4[illegible] CONTINUE                                                 EXP12030
      JJ = [illegible]                                                   EXP12040
      FPA = SPC(JJ)                                                      EXP12050
      F[illegible]A = [illegible](JJ)                                    EXP12060
      [illegible]A=(SP(JJ)-SP(JJ-1))/(FEA-S[illegible](JJ-1))            EXP12070
      FPL = SPC(JJ+K+1)                                                  EXP12080
      F[illegible] = [illegible](JJ+K+1)                                 EXP12090
      WRITE (6,6)                                                        EXP12100
    6 FORMAT(1H ,[illegible]X,'[illegible]A',11X,'FPA',12X,'F[illegible]A',12X,'FPL',12X,'FE[illegible]') EXP12110
      WRITE (6,301) [illegible]A,FPA,F[illegible]A,FPL,F[illegible]      EXP12120
  301 FORMAT(1H ,[illegible]E15.7)                                       EXP12130
      GA([illegible]) = [illegible]                                      EXP12140
      GA([illegible]) = [illegible]                                      EXP12150
      GA([illegible]) = 1.                                               EXP12160
      GA([illegible])=[illegible]                                        EXP12170
      GA([illegible]) = [illegible]                                      EXP12180
      GA([illegible]) = 1.                                               EXP12190
      GA([illegible]) = [illegible]A                                     EXP12200
      GA([illegible]) = 1.0                                              EXP12210
      GA([illegible]) = 0.0                                              EXP12220
      GB(1) = [illegible]                                                EXP12230
      GB([illegible]) = [illegible]                                      EXP12240
      GB([illegible]) = [illegible]A                                     EXP12250
      CALL [illegible](3,GA,GB)                                          EXP12260
      CALL [illegible](3,GB,[illegible]A)                                EXP12270
      CALL [illegible](3,[illegible],GB,[illegible],A,XY2)               EXP12280
      GB(1) = X(1)                                                       EXP12290
      GB(2) = X(2)                                                       EXP12300
      GB(3) = X(3)                                                       EXP12310
      WRITE (6,7)                                                        EXP12320
    7 FORMAT(1H ,[illegible]X,'GB1',12X,'GB2',12X,'GB3')                 EXP12330
      WRITE (6,400) (GB(J), J=1,3)                                       EXP12340
  400 FORMAT(1H ,[illegible]E15.7)                                       EXP12350
      DO 4[illegible] J = 1,K                                            EXP12360
      P[illegible] =(GB(1)+[illegible](J)+GB(2))/[illegible](J)+GB(3)    EXP12370
      [illegible](J+JJ) = [illegible]                                    EXP12380
   4[illegible] CONTINUE                                                 EXP12390
      IF ([illegible] .GE. [illegible]) GO TO 51                         EXP12400
```

```
      J1 = I-K-L                                                        EXP12410
      J2 = I-L                                                          EXP12420
      WRITE ( [illegible] )                                             EXP12430
    [illegible] FORMAT(////[illegible],'J',[illegible]X,'JJ',7X,'S[illegible](J)',[illegible]X,'SP(J)',10X,'SPC(J)',12X,EXP12440
     *'[illegible]',12X,'[illegible]')                                  EXP12450
      DO [illegible] J = 1, I                                           EXP12460
      [illegible] = SPC(J) -SP(J)                                       EXP12470
      HPC = [illegible]/SP(J)                                           EXP12480
      JJ = [illegible]                                                  EXP12490
      IF ( J .GT. J1) JJ = 2                                            EXP12500
      IF ( J .GT. J2) JJ = 3                                            EXP12510
      WRITE([illegible], [illegible]) J,JJ,S[illegible](J),SP(J),SPC(J),[illegible]PC,HPC  EXP12520
  [illegible] FORMAT([illegible]15,[illegible]15.7)                     EXP12530
  [illegible] CONTINUE                                                  EXP12540
      DO [illegible] J =1,I                                             EXP12550
      [illegible](J) = [illegible](J)                                   EXP12560
      [illegible](I+J) = 0.0                                            EXP12570
      IF ( SP(J) .GT. 0.0) [illegible](I+J) = ALOG10(SP(J))             EXP12580
      [illegible](I+I+J) = 0.0                                          EXP12590
      IF (SPC(J) .GT. 0.0) [illegible](I+I+J) = ALOG10(SPC(J))          EXP12600
  [illegible] CONTINUE                                                  EXP12610
[illegible] [illegible](I+J) = ALOG10(SP(J))                            EXP12620
[illegible] [illegible](I+I+J) = ALOG10(SPC(J))                         EXP12630
      CALL [illegible]([illegible],1,3,J,1)                             EXP12640
   [illegible] CONTINUE                                                 EXP12650
      [illegible]TA1=[illegible](I-L-K)                                 EXP12660
      [illegible] = [illegible](I[illegible]+1)                         EXP12670
      RETURN                                                            EXP12680
 1000 CONTINUE                                                          EXP12690
         A[illegible] = 1. - AA                                         EXP12700
      IF( [illegible] .GT. [illegible]TA1) GO TO 331                    EXP12710
      [illegible] =(AA/(1./( [illegible]A+1.)-AL[illegible]))**GA       EXP12720
      [illegible] = 1./( [illegible]A+1.0)                              EXP12730
      [illegible] = [illegible] 1 [illegible]/AA[illegible](AA/([illegible]1-AL[illegible]))**(GA+1.0)  EXP12740
      GO TO 340                                                         EXP12750
  [illegible] IF( [illegible] .GT. [illegible]) GO TO 33[illegible]     EXP12760
      [illegible] = ([illegible])*[illegible]TA*[illegible](2)          EXP12770
      [illegible] = [illegible]([illegible])*[illegible]TA*[illegible](2)  EXP12780
      GO TO 340                                                         EXP12790
  [illegible] [illegible]A = [illegible](K[illegible]+1)                EXP12800
      [illegible] = [illegible](K[illegible]+1)                         EXP12810
      DO 447 I[illegible]=1,K[illegible]                                EXP12820
      IF ( I[illegible] .GT. K[illegible]) GO TO 447                    EXP12830
      [illegible] = [illegible]+[illegible](KP-I)[illegible]CF(KP-I[illegible]+1)  EXP12840
  447 [illegible] = [illegible]*[illegible]TA+C[illegible](KP-I[illegible]+1)  EXP12850
  340 CONTINUE                                                          EXP12860
      [illegible] = [illegible]((1.[illegible]/([illegible]))                  EXP12870
      [illegible] = 0.0                                                 EXP12880
      RETURN                                                            EXP12890
      END                                                               EXP12900
```

```
      SUBROUTINE POLY(NW,N,M,IP,X,YY,CF)                                      EXP12910
      DIMENSION X(1),YY(1),C(30,5),YC(30),B(5,1),Y(30,1),A(5,5),CF(1),        EXP12920
     * WW(30),DY(30) ,P(300)                                                 EXP12930
      L = 1                                                                   EXP12940
      DO 50 I = 1,N                                                           EXP12950
      Y(I,1) = YY(I)                                                          EXP12960
      WW(I) = 1.0                                                             EXP12970
   50 C(I, 1) = 1.0                                                           EXP12980
      MP1 = M+1                                                               EXP12990
      DO 55 J =2, MP1                                                         EXP13000
      DO 55 I = 1, N                                                          EXP13010
   55 C(I,J) = C(I, J-1)*X(I)                                                 EXP13020
      DO 40 I = 1, MP1                                                        EXP13030
      DO 40 J = 1, MP1                                                        EXP13040
      A(I,J) =0.                                                              EXP13050
      DO 40 K =1, N                                                           EXP13060
   40 A(I,J) = A(I,J) + C(K,I)*C(K,J) *WW(K)                                  EXP13070
      DO 45 J = 1, L                                                          EXP13080
      DO 45 I =1, MP1                                                         EXP13090
      B(I,J) = 0.                                                             EXP13100
      DO 45 K = 1, N                                                          EXP13110
   45 B(I,J) = B(I,J) + C(K,I)*Y(K,J) *WW(K)                                  EXP13120
      CALL CHARS(A, MP1, B, L, DET)                                           EXP13130
      WRITE (6, 111)                                                          EXP13140
  111 FORMAT(1H1,' POLYNOMIAL REGRESSION ...')                                EXP13150
      WRITE (6, 301) N                                                        EXP13160
  301 FORMAT(1H ,' THE NUMBER OF GIVEN DATA POINTS=', I3)                     EXP13170
      WRITE (6, 302) M                                                        EXP13180
  302 FORMAT(1H , ' THE DEGREE OF POLYNOMIAL=',I3)                            EXP13190
      DO 33 J = 1, L                                                          EXP13200
      DO 33 I = 1, MP1                                                        EXP13210
      II = I - 1                                                              EXP13220
 1007 FORMAT(1H0,3)                                                           EXP13230
   33 WRITE (6, 303) II, B(I,J)                                               EXP13240
      WRITE(6,10)                                                             EXP13250
   10 FORMAT(1H0//27X,18HTABLE OF RESIDUALS//10H OBSERVATION NO.,5X,7HX       EXP13260
     *VALUE,7X,7HY VALUE,7X,10HY ESTIMATE,7X,8HRESIDUAL/)                     EXP13270
  303 FORMAT(1H0, I5,'   DEGREE COEFFICIENT= ', E16.9)                        EXP13280
      NN2 = N                                                                 EXP13290
      NN3 = N + 1                                                             EXP13300
      DO 75 J = 1, N                                                          EXP13310
      YC(J) = 0.                                                              EXP13320
      DO 60 I = 1, L                                                          EXP13330
      DO 60 I = 1, MP1                                                        EXP13340
      II = I - 1                                                              EXP13350
      IF (X(J) .EQ. 0.0) GO TO 30                                             EXP13360
      YC(J) = YC(J) + B(I, IL)*X(J)**II                                       EXP13370
   60 CONTINUE                                                                EXP13380
      GO TO 65                                                                EXP13390
   30 YC(J) = B(1,IL)                                                         EXP13400
   65 CONTINUE                                                                EXP13410
      DY(J) = Y(J,1 ) - YC(J)                                                 EXP13420
      NN = NN + 1                                                             EXP13430
      NN3 = NN3 + 1                                                           EXP13440
      P(J) = X(J)                                                             EXP13450
      P(NN) = YY(J)                                                           EXP13460
      P(NN3) = YC(J)                                                          EXP13470
   75 WRITE (6, 504) J,X(J),YY(J),YC(J),DY(J)                                 EXP13480
  504 FORMAT(1H ,5X,I5,E15.5,E14.5,E17.5,E15.5)                               EXP13490
      CALL PLTL(1, N,M,3,0,1)                                                 EXP13500
      DO 1000 I = 1, MP1                                                      EXP13510
 1000 CF(I) = B(I,1)                                                          EXP13520
```

```
THIS SUBROUTINE IS FOR MATRIX INVERSION AND SIMULT. LINEAR EQS.
      SUBROUTINE CHAPS (A,N,B,M,SET)                                    EXP13560
      DIMENSION IPVOT(5),INDEX(5,2),PIVOT(5),A(5,5),B(5,1)              EXP13570
      COMMON IPVOT, INDEX, PIVOT                                        EXP13580
      EQUIVALENCE (IROW, JROW), (ICOL, JCOL)                            EXP13590
      FOLLOWING 3 STATEMENTS FOR INITIALIZATION                         EXP13600
   [illegible] = 1.                                                     EXP13610
      DO 17 J = 1, N                                                    EXP13620
   17 IPVOT(J) = 0                                                      EXP13630
      DO 135 I = 1, N                                                   EXP13640
      FOLLOWING 12 STATEMENTS FOR SEARCH FOR PIVOT ELEMENT              EXP13650
      T = 0.                                                            EXP13660
      DO [illegible] J = 1, N                                           EXP13670
      IF (IPVOT(J) - 1) 13, 9, 13                                       EXP13680
   13 DO 23 K = 1, N                                                    EXP13690
      IF (IPVOT(K) - 1) 43, 23, 21                                      EXP13700
   43 IF( ABS(T) - ABS(A(J,K))) 23, 23, 23                              EXP13710
   23 IROW = J                                                          EXP13720
      ICOL = K                                                          EXP13730
      T = A(J, K)                                                       EXP13740
   23 CONTINUE                                                          EXP13750
    9 CONTINUE                                                          EXP13760
      IPVOT(ICOL) = IPVOT(ICOL) + 1                                     EXP13770
      FOLLOWING 15 STATEMENT TO PUT PIVOT ELEMENT ON DIAGONAL           EXP13780
      IF (IROW - ICOL) 75, 109, 75                                      EXP13790
   75 [illegible]                                                       EXP13800
      DO 12 L = 1, N                                                    EXP13810
      T = A(IROW, L)                                                    EXP13820
      A(IROW, L) = A(ICOL, L)                                           EXP13830
   12 A(ICOL, L) = T                                                    EXP13840
      IF (M) 109,109,33                                                 EXP13850
   [illegible]                                                          EXP13860
      [illegible] = B(ICOL, L)                                          EXP13870
      T = B(IROW, L)                                                    EXP13880
   [illegible] B(ICOL, L) = T                                           EXP13890
  109 INDEX(I,1) = IROW                                                 EXP13900
      INDEX(I,2) = ICOL                                                 EXP13910
      PIVOT(I) = A(ICOL, ICOL)                                          EXP13920
      [illegible] = SET+PIVOT(I)                                        EXP13930
      FOLLOWING 5 STATEMENTS TO DIVIDE PIVOT ROW&BY PIVOT ELEMENT       EXP13940
      A(ICOL, ICOL) = 1.                                                EXP13950
      DO [illegible] L = 1, N                                           EXP13960
  [illegible] A(ICOL,L) = A(ICOL,L)/PIVOT(I)                            EXP13970
      IF (M) 347, 347, 66                                               EXP13980
   [illegible] L = 1, M                                                 EXP13990
   [illegible] B(ICOL, L) = B(ICOL, L)/PIVOT(I)                         EXP14000
      FOLLOWING 10 STATEMENTS TO REDUCE NON-PIVOT ROWS                  EXP14010
  [illegible] DO 135 LI = 1, N                                          EXP14020
      IF(LI - ICOL) 21, 135, 21                                         EXP14030
   21 T = A(LI, ICOL)                                                   EXP14040
      [illegible] L = 1, N                                              EXP14050
   [illegible] A(LI, L) = A(LI, L) - A(ICOL, L) *T                      EXP14060
      IF (M) 135, 135, 1[illegible]                                     EXP14070
   [illegible] L = 1, [illegible]                                       EXP14080
   [illegible] B(LI, L) = B(LI, L) - B(ICOL, L) *T                      EXP14090
  135 CONTINUE                                                          EXP14100
      FOLLOWING 11 STATEMENTS TO INTERCHANGE&COLUMNS                    EXP14110
   [illegible] L = 1, N                                                 EXP14120
      [illegible] = L + 1                                               EXP14130
      IF (INDEX(L, 1) - INDEX(L, 2)) 19, 3, 19                          EXP14140
   19 JROW = INDEX(L, 1)                                                EXP14150
      JCOL = INDEX(L,2)                                                 EXP14160
                                                                        EXP14170
```

```
      [illegible] = 1, N                                                EXP14180
      T = A(K, JCOL)                                                    EXP14190
      A(K, JCOL) = A(K, JCOL)                                           EXP14200
      A(K, JCOL) = T                                                    EXP14210
[illegible]                                                             EXP14220
[illegible]                                                             EXP14230
[illegible]                                                             EXP14240
[illegible]                                                             EXP14250
```

```
      SUBROUTINE PLTL([illegible],A,[illegible],NL,[illegible])
      DIMENSION [illegible](101),YPS(11),ANG([illegible]),A(1)
      DATA [illegible]/1H /
      DATA [illegible]/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9/
    1 FORMAT(1H1,[illegible],7H CHART ,I3,//)
    2 FORMAT(1H [illegible],101A1)
    3 FORMAT(1H )
    6 FORMAT(10A1)
    7 FORMAT(1H ,10X,101H.
     .         .         .         .         .         .         .
    8 FORMAT(1H0,[illegible],11H 10.[illegible])
      NLL = NL
      IF ([illegible]) 10,10,10
   10 DO 15 I = 1,[illegible]
      DO 14 J = 1,[illegible]
      IF ( A(I) -A(J)) 14,14,11
   11 L = I + K
      LL = J-[illegible]
      DO 12 K=1,[illegible]
      [illegible] = [illegible] + [illegible]
      LL = LL + [illegible]
      [illegible] = A(L)
      A(L) = A(LL)
   12 A(LL) = [illegible]
   14 CONTINUE
   15 CONTINUE
   16 IF (NLL) 20,15,20
   17 NLL = 50
   20 WRITE (6,1) [illegible]
      XSCAL =(A(N)-A(1))/(FLOAT(NLL-1))
      [illegible] = [illegible] + [illegible]
      YMIN = A(M1)
      YMAX = YMIN
      [illegible] = [illegible]
      DO 40 J = M1, [illegible]
      IF ( A(J)-YMIN) 25,26,26
   26 IF ( A(J)-YMAX) 40,40,30
   25 YMIN = A(J)
      [illegible] = 40
   30 YMAX = A(J)
   40 CONTINUE
      YSCAL =(YMAX - YMIN)/100.0
      YPS(1) = YMIN
      DO 40 KN = 1,[illegible]
   50 YPS(KN+1) = YPS(KN)+YSCAL*10.0
      YPS(11) = YMAX
      WRITE (6,[illegible]) [illegible]
      WRITE (6,[illegible])
      [illegible] = A(1)
      [illegible] = 1
      [illegible] = [illegible] - 1
      [illegible] = 1
   [illegible] = [illegible] - 1
      [illegible] = [illegible] + [illegible]
      IF ( A(L)-YPS) 50,50,70
   [illegible] = [illegible] - 1,101
   [illegible] = [illegible]
      [illegible] = 1,[illegible]
      LL = L + [illegible]
      [illegible] =((A(LL)-YMIN)/YSCAL)+1.0
      [illegible] = A(J)
   [illegible] CONTINUE
```

```
      WRITE (6,[illegible]) XP[illegible],([illegible](IZ),IZ=1,[illegible])                    EXP14[illegible]
      [illegible]                                                                EXP14[illegible]
      [illegible]                                                                EXP14[illegible]
   70 WRITE ([illegible])                                                        EXP14[illegible]
   [illegible] [illegible]                                                       EXP14[illegible]
      [illegible]                                                                EXP14[illegible]
      [illegible]                                                                EXP14[illegible]
      XP[illegible] = [illegible](N)                                             EXP14[illegible]
      [illegible]                                                                EXP14[illegible]
   [illegible] WRITE ([illegible])                                               EXP14[illegible]
      WRITE ([illegible]) (YP[illegible](I[illegible]),IP=1,11)                  EXP14[illegible]
      [illegible]                                                                EXP14[illegible]
      [illegible]                                                                EXP14[illegible]
```

```
      SUBROUTINE PHASE2(P[illegible],TA,PA,C)
      COMMON/PV/X,[illegible],XL,[illegible],DL,[illegible],CA,[illegible],P1,P2,PC,-AT,IPHASE,
     [illegible]
      DIMENSION [illegible](200),[illegible](200),TA(4,4),GA(2,2),TB(4),GB(3),WR(100),VG(200
     [illegible]),VI([illegible]),[illegible]([illegible]),[illegible](200)
      [illegible] DL([illegible]),X([illegible])
      IF ( [illegible] .[illegible]. 1) GO TO 1000
      AL = [illegible]
      [illegible] = 0.0
      A = A[illegible]
      [illegible] = [illegible]
      [illegible] = DA
      AL = [illegible]
      A = [illegible]
      G = [illegible]
      [illegible] = [illegible]
      I[illegible] = -1
      VAI = 0.0
      [illegible] = 0.
      I = 0.
      [illegible] = 1.0
      AR = 1./A
      [illegible] = [illegible]
      [illegible] = P0[illegible]
      [illegible] = AL[illegible]*XA*[illegible]CA
      GR = 0.
      IF ( [illegible] .[illegible]. 0.) GO TO [illegible]9[illegible]
      GR = 1./[illegible]
      [illegible] = [illegible]
      [illegible] = [illegible]
      [illegible] = 1.[illegible]00
      [illegible] = [illegible]
      [illegible] = [illegible]*(P0B/([illegible]))**[illegible]
      AI = [illegible]([illegible]0/[illegible])**[illegible]
     [illegible] 1./([illegible]AL+AI[illegible]))-1.
      [illegible] = [illegible](([illegible]+1.)*X[illegible])[illegible]AR
      [illegible] = [illegible]X-[illegible]
      V[illegible] = [illegible]X/[illegible]
      IF ( [illegible](VAI) .[illegible]. 1.0) GO TO 10
      [illegible]AI = [illegible]*(XA/(1./([illegible]+1.)-XL))**[illegible]
      [illegible] = [illegible]
      VAI = [illegible]I/[illegible]
 10   CONTINUE
      I[illegible] ([illegible]) 11,12,10
 11   IF ( [illegible](VAI) .LT. 0.1) GO TO 10
      [illegible]
      [illegible]
      [illegible]
      [illegible] ( [illegible]+1.)*([illegible]+1.)*((P0B/([illegible]+[illegible]))**(AR+1.)*K[illegible]*AR/P0B
     [illegible] ([illegible]0/[illegible])**([illegible]+1.)*XA*GR/P0)
      [illegible] = 1./[illegible]A
      [illegible](1) = [illegible]
      [illegible](1) = [illegible]
      [illegible] = 1
      [illegible] = 1[illegible]
 1[illegible] IF ( [illegible](V[illegible]A) .[illegible]. 0.1) GO TO 1[illegible]
      I[illegible] = 1
      [illegible]([illegible]+1.)[illegible]((P0[illegible]/(P+B))**(AR+1.)*X[illegible]AR/P0)*(P0/P)**(GR+1.)*XA
     [illegible]*[illegible]/P0)
      [illegible] = 1./[illegible]
      I
      I[illegible]
```

```
C       [illegible]=([illegible]A+1.)[illegible]((POB/(PA+[illegible]))[illegible](AK+1.)[illegible]XE[illegible]/POB+(PB/PA)[illegible](GR+1.
C     [illegible])[illegible]X[illegible]/PO)
C        C = [illegible]T((1.[illegible]/(D[illegible]D[illegible]))
  [illegible] FORMAT([illegible] 12.4)
        [illegible]
      END
```

```
      SUBROUTINE DECOMP(N,A,UL)                                         EXP15030
      DIMENSION A(30,30),UL(30,30),SCALES(30),IPS(30)                   EXP15040
      COMMON /DECOM / IPS                                               EXP15050
      [illegible]                                                       EXP15060
      INITIALIZE IPS, UL AND SCALES                                     EXP15070
      [illegible] = 1, [illegible]                                      EXP15080
      IPS(I) = I                                                        EXP15090
      [illegible] = 0.0                                                 EXP15100
      [illegible] J = 1, N                                              EXP15110
      UL(I,J) = A(I,J)                                                  EXP15120
      IF ( [illegible] - ABS(UL(I,J))) 1,2,2                            EXP15130
    1 [illegible] = ABS(UL(I,J))                                        EXP15140
    2 CONTINUE                                                          EXP15150
      IF ( [illegible]) 3,4,3                                           EXP15160
    3 SCALES(I) = 1.0/[illegible]                                       EXP15170
      GO TO 5                                                           EXP15180
    4 CALL SING(I)                                                      EXP15190
      SCALES(I) = 0.0                                                   EXP15200
    5 CONTINUE                                                          EXP15210
      GAUSSIAN ELIMINATION WITH PARTIAL PIVOTING                        EXP15220
      NM1 = N - 1                                                       EXP15230
      DO 17 K = 1, NM1                                                  EXP15240
      BIG = 0.0                                                         EXP15250
      DO 11 I = K,N                                                     EXP15260
      IP = IPS(I)                                                       EXP15270
      SIZE = ABS(UL(IP,K))*SCALES(IP)                                   EXP15280
      IF ( SIZE - BIG) 11,11,10                                         EXP15290
   10 BIG = SIZE                                                        EXP15300
      IDXPIV = I                                                        EXP15310
   11 CONTINUE                                                          EXP15320
      IF ( BIG ) 13,12,13                                               EXP15330
   12 CALL SING(2)                                                      EXP15340
      GO TO 17                                                          EXP15350
   13 IF (IDXPIV - K) 14,15,14                                          EXP15360
   14 J = IPS(K)                                                        EXP15370
      IPS(K) = IPS(IDXPIV)                                              EXP15380
      IPS(IDXPIV) = J                                                   EXP15390
   15 KP = IPS(K)                                                       EXP15400
      PIVOT = UL(KP,K)                                                  EXP15410
      KP1 = K + 1                                                       EXP15420
      DO 16 I = KP1,N                                                   EXP15430
      IP = IPS(I)                                                       EXP15440
      [illegible] = UL(IP,K)/PIVOT                                      EXP15450
      UL(IP,K) = [illegible]                                            EXP15460
      DO 16 J = KP1,N                                                   EXP15470
      UL(IP,J) = UL(IP,J)+[illegible]*UL(KP,J)                          EXP15480
   16 CONTINUE                                                          EXP15490
   17 CONTINUE                                                          EXP15500
      KP = IPS(N)                                                       EXP15510
      IF (UL(KP,N)) 18,18,19                                            EXP15520
   18 CALL SING(2)                                                      EXP15530
   19 RETURN                                                            EXP15540
      END                                                               EXP15550
```

```
      SUBROUTINE SOLVE(NN,UL,B,X)                                       EXP15560
      DIMENSION UL(30,30),B(30),X(30),IPS(30)                           EXP15570
      COMMON /UL COM / IPS                                              EXP15580
      N = NN                                                            EXP15590
      NP1 = N + 1                                                       EXP15600
      IP = IPS(1)                                                       EXP15610
      X(1) = B(IP)                                                      EXP15620
      DO 2 I=2,N                                                        EXP15630
      IP = IPS(I)                                                       EXP15640
      IM1 = I - 1                                                       EXP15650
      SUM = 0.0                                                         EXP15660
      DO 1 J = 1, I-1                                                   EXP15670
    1 SUM = SUM + UL(IP,J)*X(J)                                         EXP15680
    2 X(I) = B(IP) - SUM                                                EXP15690
      IP = IPS(N)                                                       EXP15700
      X(N) = X(N)/UL(IP,N)                                              EXP15710
      DO 4 IBACK = 2, N                                                 EXP15720
      I = NP1 - IBACK                                                   EXP15730
      I GOES FROM ( N-0 ) ,.... TO 1                                    EXP15740
      IP = IPS(I)                                                       EXP15750
      IP1 = I + 1                                                       EXP15760
      SUM = 0.0                                                         EXP15770
      DO 3 J = IP1,N                                                    EXP15780
    3 SUM = SUM + UL(IP,J)*X(J)                                         EXP15790
    4 X(I) = (X(I)-SUM)/UL(IP,I)                                        EXP15800
      RETURN                                                            EXP15810
      END                                                               EXP15820
```

```
      SUBROUTINE IMPROV(NN,A,UL,B,X,DIGITS)                           EXP15830
      DIMENSION A(30,30),UL(30,30),B(30),X(30),R(30),DX(30)           EXP15840
      DOUBLE PRECISION SUM                                            EXP15850
      N = NN                                                          EXP15860
      EPS = 1.0E-[illegible]                                          EXP15870
      ITMAX = 16                                                      EXP15880
C     ******** EPS AND ITMAX ARE MACHINE DEPENDENT   *********        EXP15890
      XNORM = 0.0                                                     EXP15900
      DO 1 I=1,N                                                      EXP15910
    1 XNORM = AMAX1(XNORM,ABS(X(I)))                                  EXP15920
      IF (XNORM) 3,2,3                                                EXP15930
    2 DIGITS = -ALOG10(EPS)                                           EXP15940
      GO TO 10                                                        EXP15950
    3 DO 9 ITER = 1, ITMAX                                            EXP15960
      DO 5 I = 1,N                                                    EXP15970
      SUM = 0.0                                                       EXP15980
      DO 4 J = 1, N                                                   EXP15990
    4 SUM = SUM + A(I,J)*X(J)                                         EXP16000
      SUM = B(I) - SUM                                                EXP16010
    5 R(I) = SUM                                                      EXP16020
C     IT IS ESSENTIAL THAT A(I,J)*X(J) YIELD A DOUBLE PRECISION RESULT EXP16030
C     AND THAT THE ABOVE + AND - BE DOUBLE PRECISION.                 EXP16040
      CALL SOLVE(N,UL,R,DX)                                           EXP16050
      DXNORM = 0.0                                                    EXP16060
      DO 6 I = 1, N                                                   EXP16070
      T = X(I)                                                        EXP16080
      X(I) = X(I) + DX(I)                                             EXP16090
      DXNORM = AMAX1(DXNORM,ABS(X(I)-T))                              EXP16100
    6 CONTINUE                                                        EXP16110
      IF (ITER - 1) 8,7,8                                             EXP16120
    7 DIGITS = -ALOG10(AMAX1(DXNORM/XNORM,EPS))                       EXP16130
    8 IF (DXNORM - EPS*XNORM) 10,10,9                                 EXP16140
    9 CONTINUE                                                        EXP16150
C     ITERATION DID NOT CONVERGE                                      EXP16160
      CALL SING(2)                                                    EXP16170
   10 RETURN                                                          EXP16180
      END                                                             EXP16190
```

```
      SUBROUTINE SING(IWHY)                                             EXP16200
   11 FORMAT(54H0MATRIX WITH ZERO ROW IN DECOMPOSE.                     )EXP16210
   12 FORMAT(54H0SINGULAR MATRIX IN DECOMPOSE. ZERO DIVIDE IN SOLVE.    )EXP16220
   13 FORMAT(54H0NO CONVERGENCE IN IMPRUV. MATRIX IS NEARLY SINGULAR    )EXP16230
      NOUT = 6                                                          EXP16240
      GO TO (1,2,3),IWHY                                                EXP16250
    1 WRITE(NOUT,11)                                                    EXP16260
      GO TO 10                                                          EXP16270
    2 WRITE(NOUT,12)                                                    EXP16280
      GO TO 10                                                          EXP16290
    3 WRITE(NOUT,13)                                                    EXP16300
   10 RETURN                                                            EXP16310
      END                                                               EXP16320
```

```
[illegible] HCM(V,[illegible],IND)                                                  EXP16330
                                                                                    EXP16340
[illegible] THE EQUATION OF STATE FOR A SOLID, GAS OR                               EXP16350
[illegible] MIXTURE.                                                                EXP16360
                                                                                    EXP16370
                                                                                    EXP16380
THE PARAMETERS ARE                                                                  EXP16390
V     AN ARRAY OF DIMENSION [illegible]                                             EXP16400
      V(1)    SPECIFIC VOLUME          INPUT                                        EXP16410
      V(2)    INTERNAL ENERGY          INPUT                                        EXP16420
      V(3)    MASS FRACTION            INPUT                                        EXP16430
      V(4)    [illegible](SP/DX)       INPUT                                        EXP16440
      IF V(4) IS [illegible] NO SPALLING CALCULATION IS DONE FOR A PURE             EXP16450
      SOLID.                                                                        EXP16460
      V(5)    PRESSURE                 OUTPUT                                       EXP16470
      V(6)    TEMPERATURE              OUTPUT                                       EXP16480
      V(7)    SPECIFIC VOLUME OF SOLID OUTPUT                                       EXP16490
      V(8)    SPECIFIC VOLUME OF LIQUID OUTPUT                                      EXP16500
      V(9)    AN ARRAY OF DIMENSION 10 CONTAINING THE PARAMETERS FOR THE            EXP16510
      SOLID EQUATION OF STATE                                                       EXP16520
      S(1)    [illegible]                                                           EXP16530
      S(2)    [illegible]                                                           EXP16540
      S(3)    VSW  VOLUME TO SWITCH TO SECOND US, UP FIT                            EXP16550
      S(4)    C1                                                                    EXP16560
      S(5)    S1                                                                    EXP16570
      S(6)                                                                          EXP16580
      S(7)    [illegible]                                                           EXP16590
      S(8)    H                                                                     EXP16600
      S(9)    I                                                                     EXP16610
      S(10)   J                                                                     EXP16620
      S(11)   GAMMA                                                                 EXP16630
      S(12)   CV                                                                    EXP16640
      DIMENSION V(7),S(10),G(17),VIT(10)                                            EXP16650
      S(13)   VO  INITIAL VOLUME                                                    EXP16660
      S(14)   ALPHA                                                                 EXP16670
      S(15)   SPALL A                                                               EXP16680
      S(16)   ULTIMATE SPALL PRESSURE                                               EXP16690
      S(17)   TO  INITIAL TEMPERATURE                                               EXP16700
      S(18)   PO  INITIAL PRESSURE                                                  EXP16710
      S(19)   [illegible] INTERFACE PRESSURE                                        EXP16720
      [illegible] IS [illegible] EQUATION OF STATE                                  EXP16730
      [illegible] 17 CONTAINING THE PARAMETERS FOR THE                              EXP16740
      [illegible] EQUATION OF STATE                                                 EXP16750
      S(1)    A                                                                     EXP16760
      S(2)    [illegible]                                                           EXP16770
      S(3)    [illegible]                                                           EXP16780
      S(4)    [illegible]                                                           EXP16790
      S(5)    [illegible]                                                           EXP16800
      S(6)    [illegible]                                                           EXP16810
      S(7)    [illegible]                                                           EXP16820
      S(8)    [illegible]                                                           EXP16830
      S(9)    [illegible]                                                           EXP16840
      S(10)   [illegible]                                                           EXP16850
      S(11)   [illegible]                                                           EXP16860
      S(12)   [illegible]                                                           EXP16870
      S(13)   [illegible]                                                           EXP16880
      S(14)   I                                                                     EXP16890
      S(15)   J                                                                     EXP16900
      S(16)   CV                                                                    EXP16910
      S(17)   [illegible]                                                           EXP16920
      DATA [illegible] /0.0[illegible]/                                             EXP16930
      [illegible] INDICATOR                                                         EXP16940
      [illegible] NORMAL EXIT
```

```
C            = 1 TO 1 FOR SPALLED SOLID                                    EXP16950
C            = 1 TO -1 FOR HIGH ORDER IN ITERATION                          EXP16960
C       IN   INPUT INDICATOR FOR SHARP SHOCK BURN AND IS EQUAL TO 3         EXP16970
C       WILL GIVE HUGONIOT PRESSURE AND ENERGY FOR INPUT V AND [illegible] = 0  EXP16980
        DATA [illegible] / [illegible] /
        DATA [illegible] / [illegible] /                                    EXP17000
        DATA V[illegible] / [illegible] /                                   EXP17010
        DATA VII(5) /1.0E-5/                                                EXP17020
        DATA VII(10)/0.0/                                                   EXP17030
        V([illegible]) = V(1)                                               EXP17040
        V(7) = 0.0                                                          EXP17050
        IF (I[illegible] .EQ. [illegible]) GO TO 2                          EXP17060
        I[illegible] = 0                                                    EXP17070
    2   IF (V([illegible]) .GT. [illegible]) GO TO 10                       EXP17080
        IF (V([illegible]) .LT. [illegible]) GO TO 110                      EXP17090
        GO TO [illegible]                                                   EXP17100
C       EQUATION OF STATE FOR SOLID ONLY                                    EXP17110
   10   IF (V([illegible]) .[illegible]. S(1[illegible])) GO TO 50          EXP17120
C       FOR [illegible] PHASE [illegible] TYPE EQUATION OF STATE            EXP17130
        IF (V(1) .GT. S([illegible])) GO TO 11                              EXP17140
        IF (V(1) .LT. S(23)) GO TO 45                                       EXP17150
        V(1) = S(2[illegible])                                              EXP17160
        GO TO 45                                                            EXP17170
   11   C1 = S(1)                                                           EXP17180
        S1 = S([illegible])                                                 EXP17190
   [illegible] V[illegible] = S(1[illegible]) - V(1)                        EXP17200
        [illegible] = ((C1/(S(1[illegible])-S1*V[illegible]))**2)*V[illegible]  EXP17210
        [illegible] = ([illegible]*S(1[illegible]))*V[illegible]*0.5        EXP17220
        V([illegible]) = [illegible]*(V([illegible])-[illegible])*S(11)/V(1)  EXP17230
C       IF [illegible] HEAT CAPACITY SKIP TEMP CALCULATION                  EXP17240
        IF (S(1[illegible])) [illegible]                                    EXP17250
   [illegible] ALNV = ALOG(V(1))                                            EXP17260
        V([illegible]) = (V([illegible])[illegible]) [illegible]0./S(1[illegible])+EXP(S([illegible])+ALNV*(S(7)+ALNV*(S(8)+ALNV*EXP17270
      1 (S([illegible])+ALNV*S(10))))))                                     EXP17280
   [illegible] [illegible]                                                  EXP17290
C       [illegible] [illegible] FIT                                         EXP17300
   [illegible] C1 = S([illegible])                                          EXP17310
        S1 = S([illegible])                                                 EXP17320
        GO TO [illegible]                                                   EXP17330
C       [illegible] EQUATION OF STATE                                       EXP17340
   50   [illegible] = V([illegible])                                        EXP17350
C       IF [illegible] IS [illegible] P = P0 AND DO NOT SPALL               EXP17360
        IF (S(14)) [illegible]                                              EXP17370
   [illegible] V([illegible]) = S(1[illegible])                             EXP17380
        V([illegible]) = S(17)                                              EXP17390
        RETURN                                                              EXP17400
   [illegible] V([illegible]) [illegible]*(V([illegible])*(1.-V(1)/S(1[illegible])))*S(12)*1.[illegible]E-5/S(14)))/V(1)EXP17410
        V([illegible]) = V([illegible]) [illegible]0./S(12)*S(17)           EXP17420
        IF ([illegible] .[illegible]. [illegible]) RETURN                   EXP17430
C       IF [illegible] LESS THAN 0.0001 DO NOT SPALL                        EXP17440
        IF (S([illegible]) .LT. 0.0001) RETURN                              EXP17450
        [illegible] = [illegible](-[illegible])                             EXP17460
        [illegible] = [illegible]                                           EXP17470
        IF ([illegible] .[illegible]. S(1[illegible])) SP[illegible] = -S(1[illegible])  EXP17480
        IF ([illegible] .LT. [illegible]) S[illegible] = [illegible]        EXP17490
        IF (V([illegible]) .[illegible]. [illegible]) RETURN                EXP17500
        V([illegible]) = S([illegible])                                     EXP17510
C       [illegible] FOR SPALLED SOLID                                       EXP17520
        [illegible] = [illegible]                                           EXP17530
        RETURN                                                              EXP17540
C       EQUATION OF STATE FOR GAS ONLY                                      EXP17550
  110   A[illegible] = ALOG(V(1))                                           EXP17560
```

```
      ALNPI=G(1)+ALNV*(G(2)+ALNV*(G(3)+ALNV*(G(4)+ALNV*G(5))))
      ALNTI=G(6)+ALNPI*(G(7)+ALNPI*(G(8)+ALNPI*(G(9)+ALNPI*G(10))))
      ALNTI=G(11)+ALNV*(G(12)+ALNV*(G(13)+ALNV*(G(14)+ALNV*G(15))))
      [illegible] (ALNTI)*G(17)
C     SHARP SHOCK BURN
      IF (IND .EQ. 0) GO TO 111
      V(4)=EXP(ALNPI)+(SI-V(2))/V(1)*(G(12)+ALNV*(G(13)+G(13)+ALNV*(
     * [illegible]*G(14)+ALNV*4.*G(15))))
      V(5)=EXP(ALNTI)+(V(2)-SI)*[illegible]/G(16)
      RETURN
C     SHARP SHOCK BURN
  111 SIP = EXP(ALNPI)
      V(4) = SIP
      IF 112 IX = 1.0
      V(2) = 0.5*V(4)*(S(13)-V(1))
      V(4) = SIP + (SI-V(2))/V(1)*(G(12)+ALNV*(G(13)+G(13)+ALNV*(
     * [illegible]*G(14)+ALNV*4.*G(15))))
  112 CONTINUE
      RETURN
C     EQUATION OF STATE FOR MIXTURE OF SOLID AND GAS
  210 CMW = 1.*V(3)
      CMWR = 1./CMW
      IF (V(1) .GT. S(13)) GO TO 225
      W = 1./V(3)
      VII(1) = (V(1)-V(3)*S(13)+VGSS)*CMWR
      VII(2) = 1.002
      IND = 1
C     IND=1 FOR ITERATION ON VS
  215 CALL [illegible](X,F,VII)
      IF (VII(10)) 900,260,220
  220 IF (X .EQ. 0.) GO TO 225
      VS = X
      VS = (V(1)-CMW*VG)*WR
      IF (VS .EQ. 0.0) GO TO 225
      IF (VS .GT. S(13)) VS = S(13)
      GO TO 250
C     SET VS = VG - VOLUME WHEN GET IN TROUBLE
  225 VS = V(1)
      VS = V(1)
      X = V(1)
      GO TO 250
  230 VII(1) = V(1)
      VII(2) = [illegible]
C     IND = 2 FOR ITERATION ON VS
      IND = 2
  235 CALL [illegible](X,F,VII)
      IF (VII(10)) 900, 260, 240
  240 IF (X .EQ. 0.0) GO TO 225
      IF (X .GT. S(13)) X = S(13)
      VS = X
      VS = (V(1)-V(3)*VS)*CMWR
      IF (VS .EQ. 0.0) GO TO 225
C     CALCULATE TEMPERATURE/PRESSURE DIFFERENCE FOR MIXTURE ITERATION
  250 VGMV = S(13) - VS
      HP = ((S(1)/(S(13)-S(2)*VGMV))**2)*VGMV
      HP = (HP-S(1))*VGMV*0.5
      ALNV = ALOG(VS)
      HT = EXP(G(6)+ALNV*(G(7)+ALNV*(G(8)+ALNV*(G(9)+ALNV*G(10)))))
      ALNV = ALOG(VG)
      ALNPI=G(1)+ALNV*(G(2)+ALNV*(G(3)+ALNV*(G(4)+ALNV*G(5))))
      HT = EXP(G(6)+ALNPI*(G(7)+ALNPI*(G(8)+ALNPI*(G(9)+ALNPI*G(10)))))-
     * G(17)
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C     [illegible] [illegible] [illegible]
C     TX(1)        STARTING GUESS
C     TX(2)        [illegible] TO GET SECOND POINT
C     TX(3)        [illegible] DEFINITION
C     TX(10)       COUNT OF NUMBER OF ITERATIONS
C                  SET TO ZERO ON SOLUTION
C                  SET TO NEGATIVE OF COUNT ON ERROR
C     FP           = FUNCTION(XP)
C     WHEN A SOLUTION IS FOUND, XP IS THE ROOT
C
C     ERRORS OCCUR FOR
C           1. TOO MANY ITERATIONS, .GT. CNTMAX
C           2. TWO SUCCESSIVE XP'S OR FP'S ARE EQUAL
      DIMENSION TX(10)
      DATA CNTMAX / 1000./
      IF (TX(10) .EQ. 0.0) GO TO 1
      TX(10) = TX(10) + 1.
      IF ( TX(10) - 3.) 2,3,4
C     FIRST TIME THROUGH
    1 TX(10) = 1.
      IF(ABS(TX(1)) .LT. 0.0000000001) TX(1) = 1.
      XP = TX(1)
      [illegible] (XP)
      RETURN
C     SECOND TIME THROUGH
    2 TX([illegible]) = FP
      TX([illegible]) = XP
      TX([illegible]) = FP
      IF (ABS(FP) .LT. TX(3)) GO TO 16
      XP = TX(1) + TX(2)
      [illegible] (XP)
      RETURN
C     THIRD TIME THROUGH
    3 TX([illegible]) = FP
      TX([illegible]) = XP
      TX(7) = FP
      IF (ABS(FP) .LT. TX(3)) GO TO 16
      XP = TX([illegible])-TX([illegible])*(TX([illegible])-TX([illegible]))/(TX(7)-TX([illegible]))
      [illegible] (XP)
      RETURN
C     FOURTH AND SUCCEEDING TIMES THROUGH
    4 IF (TX(10) .GT. CNTMAX) GO TO [illegible]
      TX([illegible]) = XP
      TX([illegible]) = FP
      T = TX([illegible]) - TX([illegible])
      IF (ABS(T) .LT. 0.0000000001) GO TO [illegible]
      IF (ABS(FP) .LT. TX(3)) GO TO 13
      [illegible] = TX([illegible]) - TX(7)
      IF (ABS([illegible]) .LT. 0.0000000001) GO TO [illegible]
      XP = TX([illegible]) - TX([illegible])*(T/[illegible])
      IF(TX([illegible])*TX(7) .LT. 0.0) GO TO 11
      IF (TX([illegible])*TX([illegible]) .GE. 0.0) GO TO 11
      IF (XP .GT. TX([illegible])) GO TO [illegible]
      IF (XP .LT. TX([illegible])) GO TO 10
      XP = TX([illegible])-TX([illegible])*(TX([illegible])-TX([illegible]))/(TX([illegible])-TX([illegible]))
   10 TX(7) = TX([illegible])
      TX([illegible]) = TX([illegible])
      [illegible] (XP)
      RETURN
    [illegible] IF(XP .GT. TX([illegible])) GO TO [illegible]
      GO TO 10
   11 TX([illegible]) = TX(7)
```

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      TX(3) = TX(6)                                                     EXP19050
      GO TO 10                                                          EXP19060
C     HAVE FOUND A SOLUTION                                             EXP19070
   10 TX(10) = 0.0                                                      EXP19080
      TX(1) = XP                                                        EXP19090
      TX(4) = XP                                                        EXP19100
      RETURN                                                            EXP19110
C     AT [illegible] HAS OCCURRED                                       EXP19120
C     [illegible] COUNT NEGATIVE AND EXIT                               EXP19130
   [illegible] TX(10) = -TX(10)                                         EXP19140
      RETURN                                                            EXP19150
      END                                                               EXP19160
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POOR

QUALITY

ORIGINAL